Design Engineering Report for the Phase 2 Expansion of the Inland Bays Regional Wastewater Facilities in Sussex County, Delaware

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1 Executive Summary

1.1 Overview

Sussex County currently owns, operates, and maintains the Inland Bays Regional Wastewater Facility (IBRWF) under State Permit No. LTS 5004-90-12. This facility provides treatment of domestic wastewater and uses spray irrigation to dispose of the treated effluent on 432.5 acres of irrigated agricultural land adjacent to the treatment plant. All of the treatment plant property and spray irrigation lands are owned by Sussex County.

Sussex County (County) would like to request a permit modification from DNREC to increase both the treatment and disposal capacities of the IBRWF.

The County is seeking to increase the treatment capacity from 2.0 MGD to 4.0 MGD on a maximum monthly basis. To increase the treatment capacity, Sussex County will expand its secondary treatment facility, currently achieving biological nutrient removal (BNR) using a phased-aeration treatment process and secondary clarification. The headworks, disinfection, and solids handling systems will also be upgraded to handle the additional treatment capacity.

This expansion of IBRWF treatment capacity is the second of three phases. This Phase 2 of expansion will add two (2) additional phased-aeration treatment trains for BNR treatment, capable of treating an additional 2.0 MGD of wastewater. Upon completion of this phase, the IBRWF will be able to treat and dispose of a total of 4.0 MGD on a maximum monthly basis. Upon completion of the third phase, the IBRWF will be able to treat and dispose of a total of 6.0 MGD on a maximum monthly basis.

The County is proposing an increase in the disposal capacity of the IBRWF from 2.65 MGD to 5.4 MGD on a maximum month basis. They plan to add approximately 280 acres of total area (219.9 wetted acres) by developing two spray fields: Area C (north of Inland Bays Rd), and Area D (north of Inland Bays Rd). Fixed head spray irrigation systems will be used to discharge treated effluent onto County owned wooded land.

The Inland Bays Regional Wastewater Facility (RWF) has an existing treatment capacity of 2.0 MGD. The Phase 1 plant upgrades, completed in 2010, added biological nutrient removal (BNR). A dewatering facility with belt filter press was added to the plant in 2014. The existing plant includes the following liquid treatment facilities:

- Screening
- Biolac Aeration Lagoons
- Secondary Clarification
- Disinfection
- Effluent Storage Lagoons
- Spray Irrigation

The solids handling and dewatering facilities consist of the following:

- Secondary Sludge Pumping Station
- Waste Sludge Holding Lagoon
- Belt Filter Press Dewatering

A regional biosolids facility is included in other proposed upgrades at the facility and consists of a sludge receiving and storage facility as well as a heat drying facility. This facility will handle biosolids from Inland Bays and other wastewater treatment plants including South Coastal RWF, Wolfe Neck WRF, Rehoboth Beach Sewage Treatment Plant, and Lewes Wastewater Treatment Plant and Seaford Wastewater Treatment Facility.

A regional septage receiving facility is included in the proposed upgrades and will take the place of the existing septage receiving facility at the South Coastal WRF.

Overall facilities to be added and/or upgraded in Phase 2 include:

1) New Screening Facility
   - Two new mechanical screens in a new structure
2) New Grit Facility
   - Designed for a peak flow of 15 MGD, with the ability to expand to 22.1 MGD
3) New Aeration Lagoon Distribution Box
4) New Biolac Aeration Lagoon Expansion
   - Two additional aeration lagoons, to mirror existing Biolac aeration lagoons
5) New Clarifier Nos. 3 and 4
   - Similar design to existing Clarifiers No.1 and 2
6) New Pump and Blower Building
   - New building to house return and waste sludge pumps as well as space for future blowers
7) Regional Biosolids Facility
   - Biosolids facility sized for regional Sussex County and Rehoboth dewatered sludge
   - Facility to utilize indirect paddle-type drying unit
   - Truck unloading facility for dewatered cake
   - Unloading facility to integrate with existing storage facility and dryer facility
   - Regional septage receiving station with dual preliminary treatment units
8) Effluent Filtration Facility
   - Designed for 18.7 MGD capacity
9) Effluent Irrigation Pump Station
   - Sized for new disposal fields

2 Site Description

2.1 Location

The Inland Bays Regional Wastewater Facility (IBRWF) is located approximately 10 miles south of Lewes, Delaware. The treatment facility is situated on Sussex County owned land identified as parcel 2-34-22 on the County tax map shown in **Figure 2.1**. The existing facility is specifically located on Parcel Nos. 14, 12, and 16 for the treatment facility, North spray field, and South spray field, respectively.

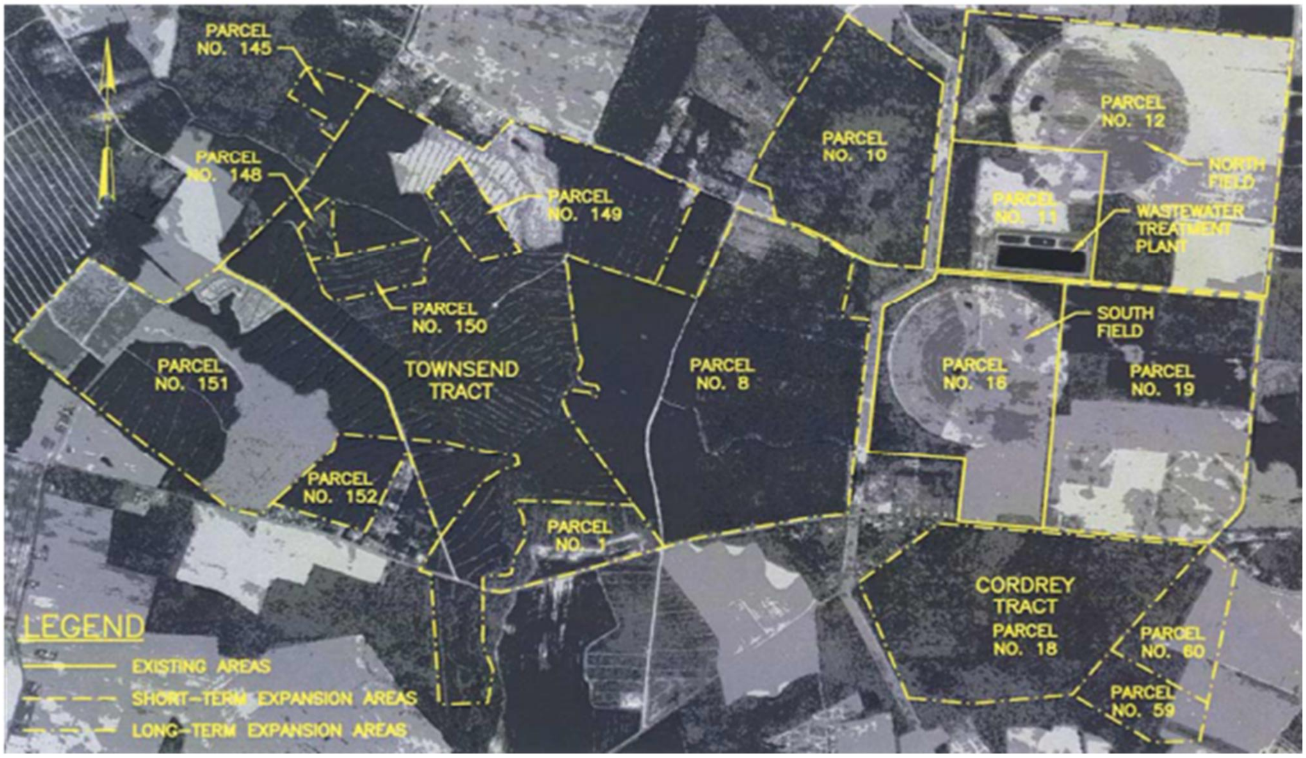


Figure 2.1: Sussex Co. Tax Map with IBRWF

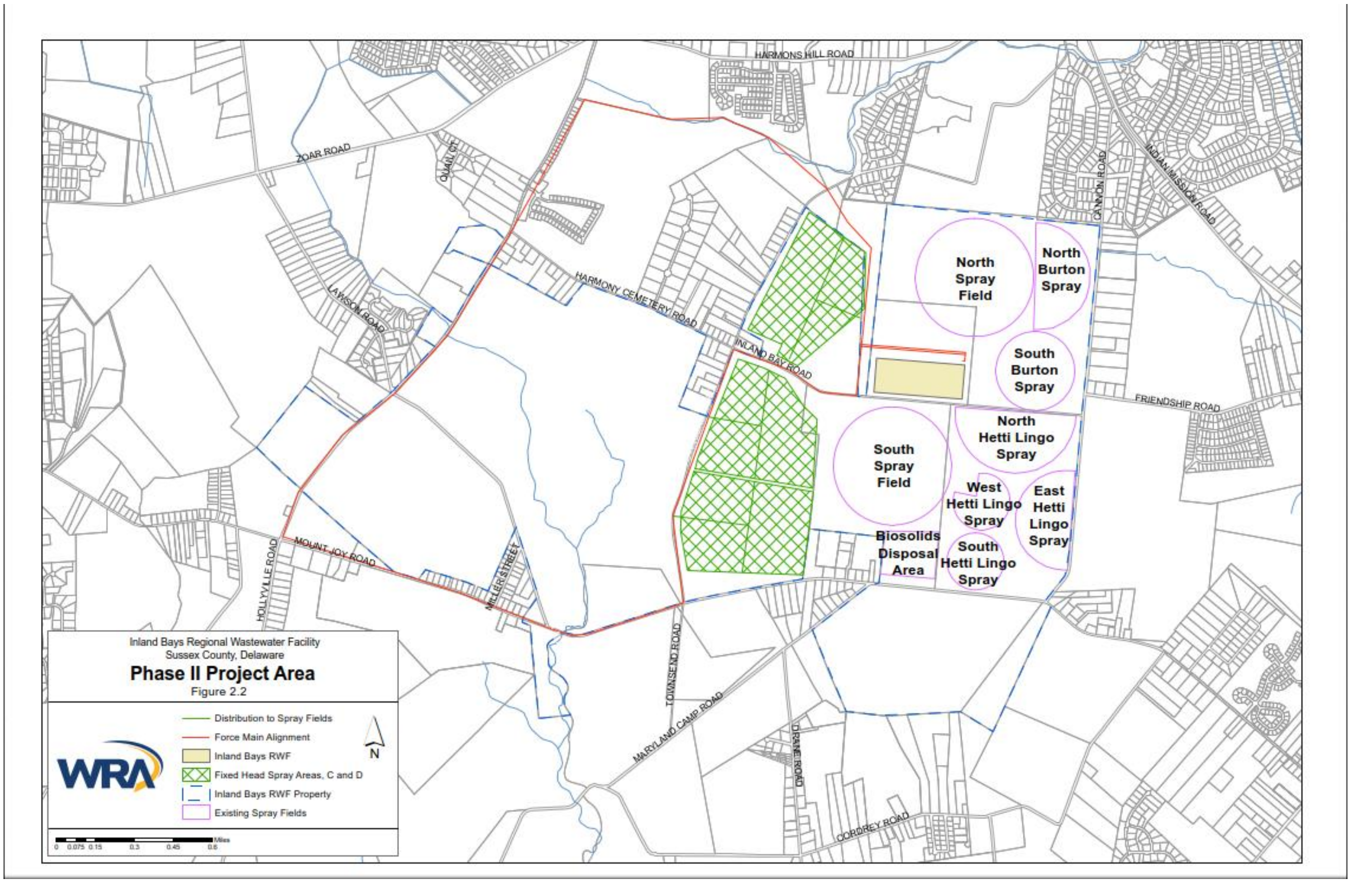


Figure 2.2: IBRWF Phase 2 Project Area

2.2 Climate

Table 2.1 summarizes the temperature and precipitation given in the DNREC On Site Wastewater Treatment and Disposal Systems Regulations, Exhibit JJ and KK. Data is for Georgetown, DE area.

Table 2.1. Inland Bays Temperature & Precipitation		
	Temperature, F	Precipitation, Inches
January	34.2	3.3
February	35.8	3.2
March	43.5	4.1
April	53.6	3.2
May	63.1	3.4
June	71.5	3.6
July	76.1	3.9
August	74.9	5.3
September	68.4	3.6
October	57.0	3.5
November	47.2	3.1
December	37.8	3.6

2.3 Geology and Topography

The topography, soil, and hydrologic characteristics of the site are described in detail in the *Hydrogeologic Report for Spray Irrigation Expansion at the Inland Bays Regional Wastewater Facilities in Sussex County, Delaware*, prepared by Whitman Requardt & Associates, October 26, 2017, and the Soil Investigation Report for Spray Irrigation; Map 234-21.00 parcels 151, 151.03, and Map 234-22.00 parcels 8.00, 10.00 (~442 acres +/-) prepared by Accent Environmental, LLC, December 5, 2016. Both of these reports have already been submitted under separate cover to DNREC.

2.4 Access

Access to the treatment facility will not be affected by the proposed expansion. The IBRWF will still be accessed by Inland Bays Road.

2.5 Monitoring Wells

There were sixteen (16) monitoring wells and one (1) observation well on the County owned parcels for Phase 1. Twenty one (21) monitoring wells were constructed in the unconfined aquifer on the County owned parcels for the Phase 2 expansion related spray irrigation fields, ranging from 14 to 26 feet deep. See October 2017 *Hydrogeologic Report for Spray Irrigation Expansion at the Inland Bays Regional Wastewater Facilities in Sussex County, Delaware* for further details about the Phase 2 monitoring wells. **Figure Nos. 2.3** and **2.4** below are copied from the report for reference.

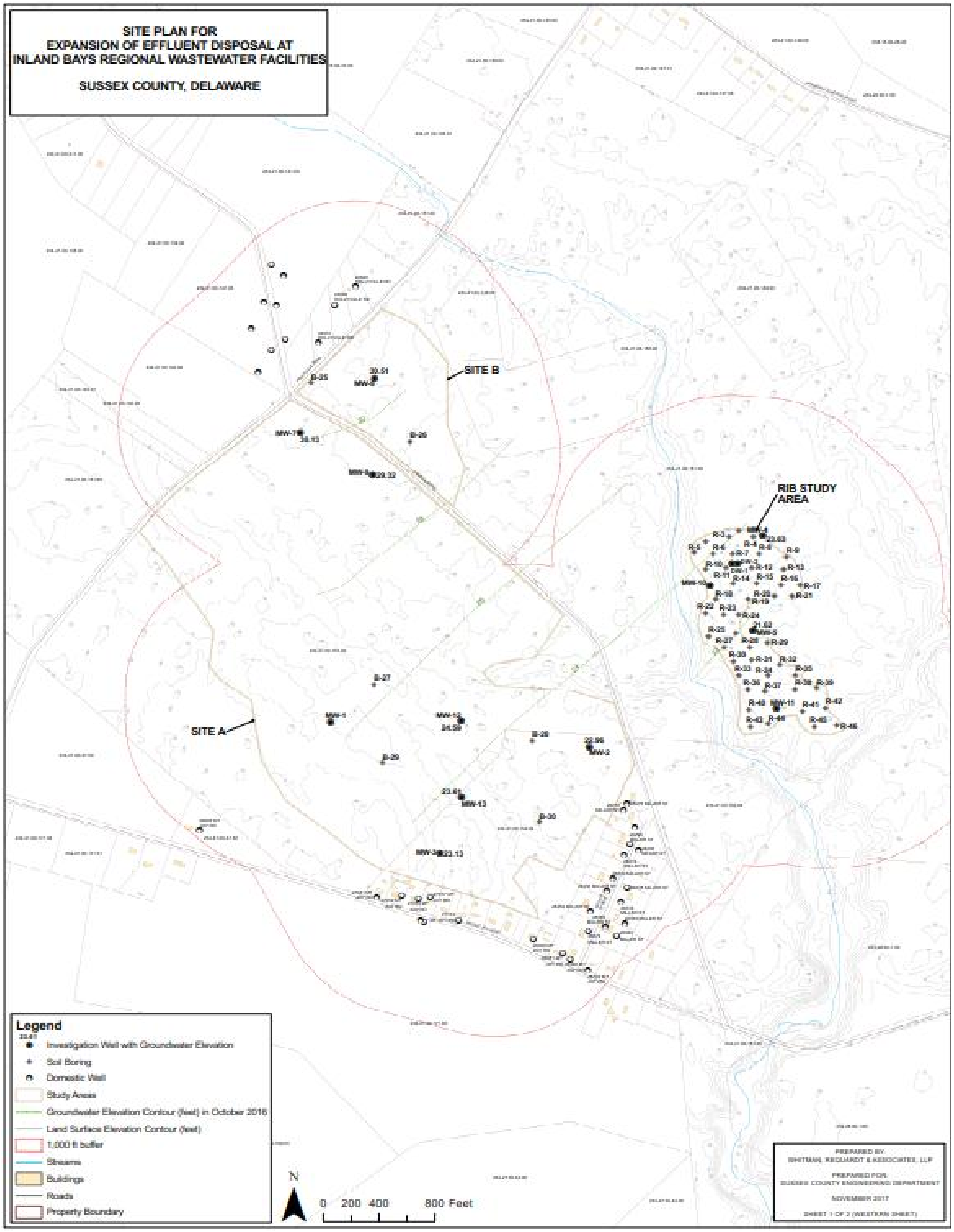


Figure 2.3: Monitoring Well Locations, Sheet 1 of 2

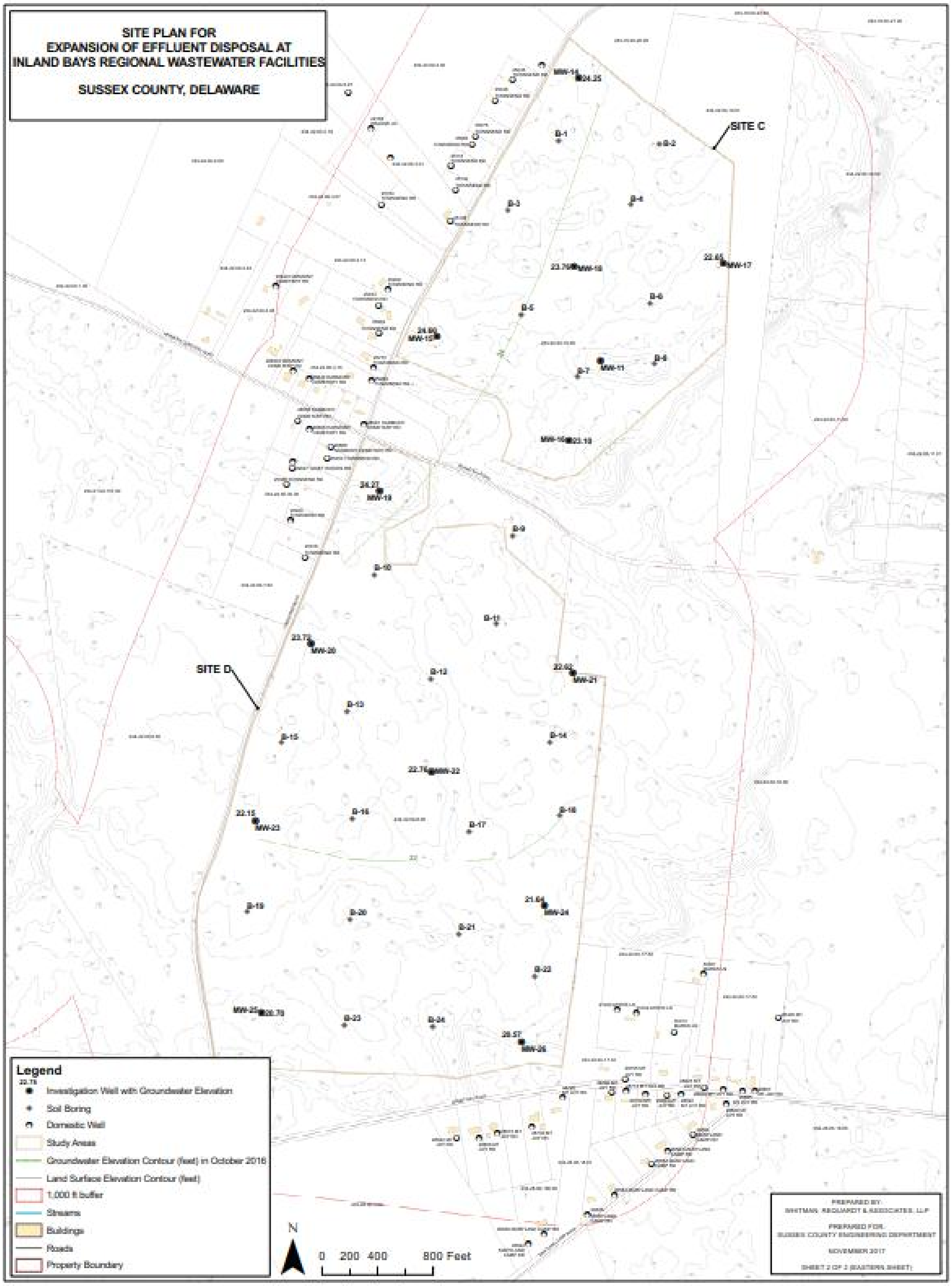


Figure 2.4: Monitoring Well Locations, Sheet 2 of 2

3 Site Layout

The Phase 2 expansion includes:

1.) Addition of a second Influent Screening Facility
2.) New Grit Facility
3.) Addition of two (2) new Aeration Lagoons
4.) Addition of two (2) new Secondary Clarifiers and a new pump and blower building
5.) Filtration Facility
6.) Irrigation Pumping Facility
7.) Regional Biosolids Facility
8.) Expansion Spray Irrigation Fields C and D

The site plan for the Phase 2 expansion is provided in Contract Drawing C02.01 and below as **Figure 3.1**.

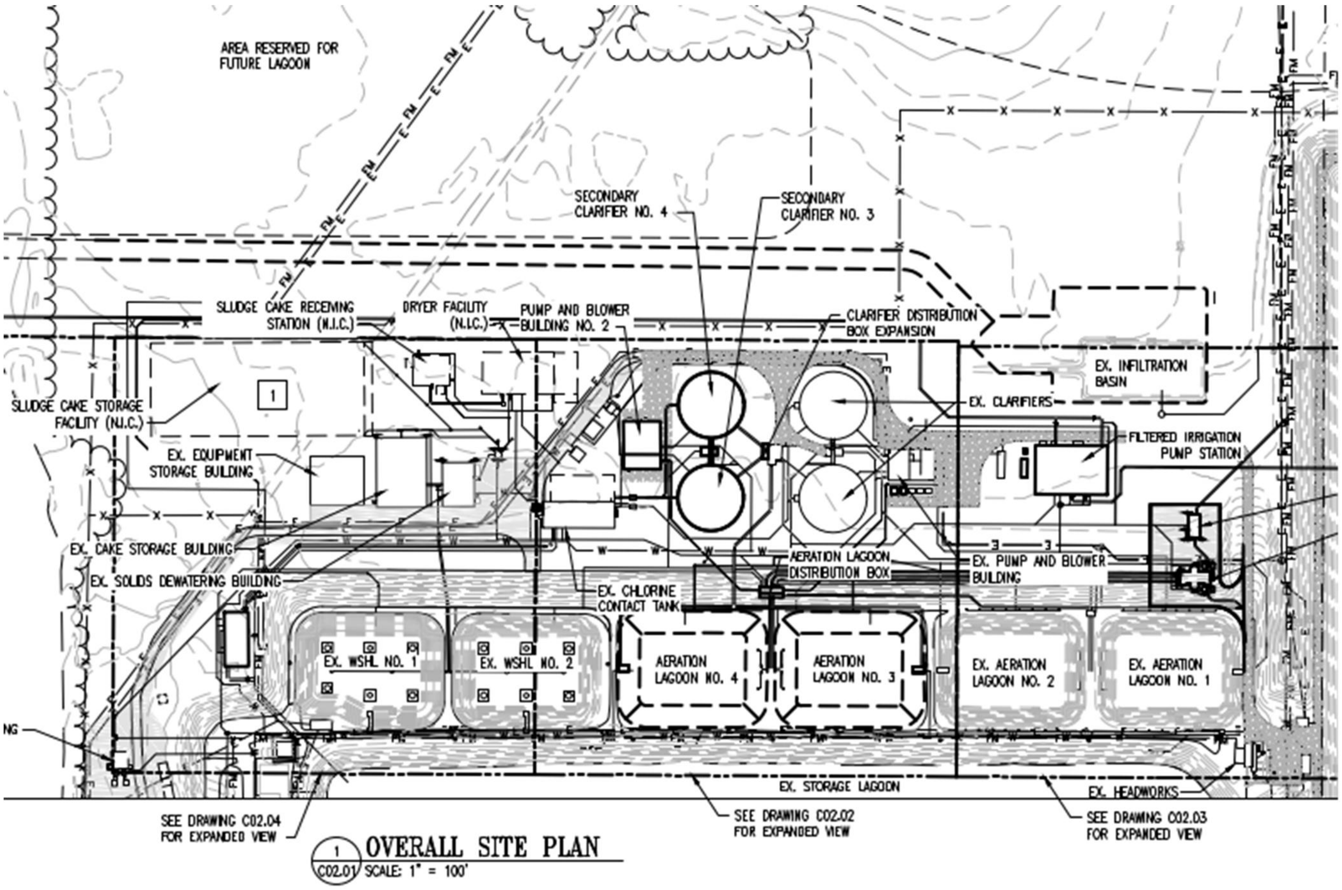


Figure 3.1: IBRWF Phase 2 Site Plan

The rate of spray application on the expansion fields is summarized in **Table 3.1.**

Table 3.1. Inland Bays Expansion Fields		
	Fields	
Parameter	C	D
Total Area (acres)	90.0	190.0
Discharge Rate[1] (mgd)	0.87	1.84
Effective Discharge Rate[2] (gpm)	2,500	5,300
Application Rate (in/week)	2.5	2.5

Notes:
1. Discharge rate is calculated for 7 day operation; intended for use as a basis of comparison.
2. Effective discharge rate is calculated for 40 hours per week projected run time for irrigation equipment.

A new irrigation pump station will be constructed as part of the treatment facility upgrade. Refer to Section 5.12 for more information about the effluent irrigation pumping system.

4 Design Wastewater Characteristics

The purpose of this section is to establish average, minimum and peak flows and loads for the plant influent to be used for the design. The Inland Bays Regional Wastewater Facility (RWF) has an existing treatment capacity of 2.0 MGD. Wastewater treated at the IBRWF comes primarily from domestic sources. The Phase 2 facility expansion will increase the plants rated maximum month treatment capacity to 4.0 MGD and an annual average treatment and disposal flow of 3.0 MGD.

Plant operating records from January 2012 through September 2016 were reviewed and tabulated. The records include plant influent concentrations (5-day Biochemical Oxygen Demand [BOD5], Total Suspended Solids [TSS], Total Kjeldahl Nitrogen [TKN], Ammonia Nitrogen [NH3-N]), as well as daily average influent and effluent flows. The data were obtained from the monthly operations reports of the Inland Bays RWF.

All flow to the plant is pumped, and many of the stations manifold into common forcemains, making the actual capacity of each station extremely variable. The peak hour plant design criteria will be based on the projected EDU and County Standard peaking calculations.

The plant receives raw sewage into the existing headworks screening facility through multiple forcemains. Influent flow rates are measured at each pump station and totalized. The influent sampler draws samples from the channel downstream of the screening channels.

4.1 Influent Wastewater Characteristics

The historical flows for 2012 through 2016 were analyzed in the *IBRWF Phase 2 Expansion Technical Memorandum,* WRA, January 2017. Flow in **Table 4.1** was calculated for the following conditions:

Summer:	June, July and August
Winter:	January, February, and December
Annual average:	The average flow rate occurring over a 24-hour period based on total annual (calendar year) data.
Maximum month:	The maximum average daily flow rate that occurs over a one month period (30 consecutive days).
Minimum day:	The minimum daily flow rate that occurs over a one calendar year period.

Table 4.1. Historical Influent Wastewater Flows (MGD)

	Summer			Winter			
Year	Min Month	Average	Max Month	Min Month	Average	Max Month	**Max Day**
2012	0.45	0.68	1.53	0.37	0.44	0.52	1.74
2013	0.45	0.76	2.12	0.37	0.49	0.94	2.12
2014	0.62	0.86	1.19	0.39	0.52	0.73	1.19
2015	0.65	0.83	1.07	0.46	0.62	0.91	1.58
2016	0.52	0.78	1.16	0.46	0.64	1.07	2.41
Average	0.54	0.78	1.48	0.40	0.52	0.78	1.66
Max	0.65	0.86	2.12	0.46	0.62	0.94	2.12

All flow to the plant is pumped, and many of the stations manifold into a common forcemain, making the actual capacity of each station extremely variable. The peak hour plant design criteria will be based on the projected EDU and County Standard peaking calculations as previously stated. The full calculation spreadsheet is in Appendix B of the *IBRWF Phase 2 Expansion Technical Memorandum,* WRA, January 2017.

The information from the historical flows and the calculated peak hour flows were reviewed to determine the appropriate design flows for the Phase 2 expansion. **Table 4.2** summarizes the projected influent wastewater flows.

Table 4.2. Projected Influent Wastewater Flows

Condition	**Flow Rate, mgd**
Summer Maximum Month ADF	4.0
Summer Average Month ADF	3.6
Winter Average Month ADF	2.8
Annual Average ADF	3.0
Max Day Flow	7.6
Peak Hour Flow	13.0

Similar to the definitions for flow variations, historical concentrations are summarized in **Tables 4.3** through **4.8** for BOD_5, TSS, NH_3-N, temperature, pH, and alkalinity respectively. TKN is also measured, but is recorded as a BOD to TKN ratio rounded to a whole number, and is therefore highly variable. The tables summarize the historic influent concentrations for the following conditions:

Summer:	June, July, August
Winter:	January, February, December
Annual average:	The average load for all the days in that year.
Maximum month:	The maximum month value.

Table 4.3. Historic Influent BOD_5

Year	Summer Average		Summer Max Month		Winter Average		Winter Max Month	
	mg/L	lbs/day	mg/L	lbs/day	mg/L	lbs/day	mg/L	lbs/day
2012	188.5	1078.5	333.0	2430.1	187.3	683.7	218.6	825.6
2013	126.1	777.3	155.6	1724.6	135.2	550.2	189.5	1047.4
2014	241.2	1712.0	330.6	2725.9	214.0	923.9	282.9	1727.1
2015	166.1	1143.6	256.0	1780.6	208.4	1076.8	255.4	1942.7
2016	164.5	1087.5	203.9	1966.0	190.4	1010.6	275.7	1954.3
Average	177.3	1159.8	255.8	2125.4	187.1	849.1	244.4	1499.4
Max	241.2	1712.0	333.0	2725.9	214.0	1076.8	282.9	1954.3

Table 4.4 Historic TSS Concentrations

Year	Summer Average		Summer Max Month		Winter Average		Winter Max Month	
	mg/L	lbs/day	mg/L	lbs/day	mg/L	lbs/day	mg/L	lbs/day
2012	292.9	1676.0	360.0	4593.7	226.6	1676.0	296.0	1113.4
2013	340.0	2103.2	450.0	5521.6	240.0	977.0	412.0	3229.9
2014	414.4	3011.8	721.3	7164.6	253.2	1092.5	387.0	2362.6
2015	267.3	1859.6	376.0	3364.8	264.8	1368.6	350.0	2662.1
2016	309.5	2032.0	355.0	3394.0	337.9	1786.2	566.0	4024.6
Average	324.8	2136.5	452.5	4807.7	264.5	1380.1	402.2	2678.5
Max	414.4	3011.8	721.3	7164.6	337.9	1786.2	566.0	4024.6

Table 4.5 TKN Concentrations

Year	Summer Average		Summer Max Month		Winter Average		Winter Max Month	
	mg/L	lbs/day	mg/L	lbs/day	mg/L	lbs/day	mg/L	lbs/day
2012	45.2	256.7	52.5	575.5	40.6	256.7	49.7	186.9
2013	44.7	282.5	48.2	799.9	38.8	157.8	42.8	318.3
2014	46.9	335.9	55.4	550.3	40.0	172.1	44.6	227.7
2015	58.2	404.3	70.5	630.9	43.3	224.6	59.9	357.7
2016	48.8	316.8	54.7	466.7	38.5	209.2	47.7	375.7
Average	48.8	319.2	56.3	604.7	40.2	204.1	48.9	293.3
Max	58.2	404.3	70.5	799.9	43.3	256.7	59.9	375.7

Table 4.6 Influent Temperature (°C)				
Year	Summer		Winter	
	Average	Max Month	Average	Max Month
2012	24.2	27.3	11.0	12.8
2013	24.1	27.4	13.2	18.7
2014	23.3	25.5	13.9	19.8
2015	24.8	28.9	13.3	19.1
2016	22.1	28.7	14.6	18.3
Average	23.7	27.6	13.2	17.7
Max	24.8	28.9	14.6	19.8

Table 4.7 Influent pH				
Year	Summer		Winter	
	Average	Max Month	Average	Max Month
2012	6.8	7.1	7.0	7.3
2013	6.9	7.3	6.9	7.2
2014	7.0	7.6	6.8	7.0
2015	6.9	7.4	7.0	7.5
2016	6.5	6.7	6.6	7.0
Average	6.8	7.2	6.9	7.2
Max	7.0	7.6	7.0	7.5

Table 4.8 Alkalinity Concentrations								
Year	Summer Average		Summer Max Month		Winter Average		Winter Max Month	
	mg/L	lbs/day	mg/L	lbs/day	mg/L	lbs/day	mg/L	lbs/day
2012	246.1	1400.7	280.0	3011.4	272.0	939.2	280.0	1053.2
2013	235.7	1825.4	301.0	5026.1	235.7	959.8	299.0	1646.3
2014	271.0	1940.6	287.0	2850.8	252.2	1087.5	290.0	1770.4
2015	260.8	1809.8	273.0	2443.0	258.8	1289.1	268.0	2038.4
2016	269.0	1753.1	290.0	2796.2	241.0	1312.1	283.0	2248.8
Average	256.5	1745.9	286.2	3225.5	251.9	1117.5	284.0	1751.4
Max	271.0	1940.6	301.0	5026.1	272.0	1312.1	299.0	2248.8

The IBRWF does not regularly measure influent phosphorus, nitrate, nitrite, sodium, or chlorides. The design basis will be based on period samples, where available, and industry standards for typical municipal wastewater. Based on the historic information, the design influent wastewater characteristics for the Phase 2 expansion were developed. The proposed septage receiving station will discharge to the aerated sludge holding tanks. **Table 4.9** summarizes the design influent wastewater characteristics.

Table 4.9. Design Influent Wastewater Characteristics without Recycle

Constituent	Summer Average	Summer Average	Winter Average	Winter Average	Summer Maximum Month	Summer Maximum Month
	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)
BOD_5	190	5,700	190	4,400	247	8,200
TSS	220	6,600	220	5,100	286	9,500
TKN	40	1,200	40	930	52	1,700
NH_4-N	25	750	25	580	33	1,100
NO_3,NO_2	<1	<1	<1	<1	<1	<1
TN	40	1,200	40	930	52	1,700
TP	7	210	7	160	9	300
pH	5.5-9.0	---	5.5-9.0	---	5.5-9.0	---
Sodium[1]	170	---	170	---	160	---
Chlorides[1]	160	---	160	---	160	---
Alkalinity	251	7,500	251	5,900	326	10,900

[1] Any addition or removal of sodium or chlorides are incidental to the treatment process. The influent concentrations are based on average effluent concentrations measured for the period 2011-2016

4.2 Effluent Wastewater Characteristics

The IBRWF has a spray irrigation permit (State Permit No. LTS 5004-90-12) issued by the State of Delaware Department of Natural Resources and Environmental Control (DNREC) which allows land application of pre-treated effluent to spray the fields. The permit includes effluent limitations, monitoring requirements, and application conditions for regulating parameters of the pretreatment facility and spray irrigation system. Parameters regulated by the permit include influent and effluent flows, concentrations for specific pollutant constituents, pH, chlorine residual, fecal coliform, application rates, and an annual nitrogen loading rate. Monitoring requirements include frequency of sampling and sampling procedures for specific groundwater and soil parameters. A summary of key permit limits is provided in **Table 4.10**.

Table 4.10. Key Permit Limits for Sprayed Effluent		
PARAMETER MAXIMUM ALLOWABLE[1]	**VALUE**	
Biochemical Oxygen Demand (BOD5)	50 mg/L Daily Average	
Total Suspended Solids (TSS)	90 mg/L Daily Average	
Fecal Coliform	200 colonies/100 mL Daily Average	
Chloride	250 mg/L Daily Average	
Sodium	210 mg/L Daily Average	
Total Residual Chlorine	1.0 mg/L Minimum	4.0 mg/L Maximum
pH	5.5 Minimum	9.0 Maximum
Maximum TN applied[2]	250 lb/yr/ac	

[1] State Permit No. LTS 5004-90-12.

[2] TN load applied includes supplemental fertilizers, if any.

The current permit states that the average quantity of effluent discharged to any portion of the spray irrigation fields shall not exceed 1.86 inches per acre per week with a maximum field application rate of 0.25 inches per hour. A 24-hour rest period between is required between applications. The permit prohibits the application of wastewater during periods of rainfall, snowfall and when the ground is frozen.

The Groundwater Monitoring section of the permit requires grab samples be taken every quarter from the ten monitoring wells located on the property and submitted in a report to DNREC. However, the permit does not provide requirements for the measured values. **Table 4.11** provides a summary of the monitoring parameters.

Table 4.11. Summary of Groundwater Monitoring Parameters			
PARAMETER MAXIMUM ALLOWABLE[1]	**UNITS**	**MEASUREMENT FREQUENCY**	**SAMPLE TYPE**
Ammonia as Nitrogen	mg/L	Quarterly	Grab
Depth to Water	Hundredth of feet	Monthly	In-Situ
Dissolved Oxygen	mg/L	Quarterly	Field Test
Specific Conductance	µS/cm	Quarterly	Grab
Nitrate + Nitrite as Nitrogen	mg/L	Quarterly	Grab
Temperature	ºC	Quarterly	Field Test
pH	S.U.	Quarterly	Field Test
Sodium	mg/L	Quarterly	Grab
Chloride	mg/L	Quarterly	Grab
Fecal Coliform	Col/100 mL	Quarterly	Field Test
Total Dissolved Solids	mg/L	Quarterly	Grab
Total Nitrogen	mg/L	Quarterly	Grab
Total Phosphorus	mg/L	Quarterly	Grab

The facility is required to submit a spray effluent discharge permit Compliance Monitoring Report (CMR) was submitted in May 2017. The CMR reviewed the total nitrogen, phosphorus, sodium, chloride, and metals in the wastewater effluent.

From the nitrogen balance spreadsheets included in the CMR, it was concluded that the application of chemical fertilizer, not the application of wastewater that is the driver of any monthly excess nitrogen in the percolate. It was recommended chemical nitrogen fertilizer be eliminated or spread out over the growing season to affect the excess total nitrogen being applied, which is especially high in the month it is applied. With the elimination or modification of chemical nitrogen fertilizer application to the vegetative management plans, the fields indicated no issues to continuing to assimilate the nitrogen applied by wastewater effluent irrigation.

The Soils Report included in the CMR indicated phosphorus as the limiting soil constituent. It also classifies the phosphorus levels in the soil, as indicated by cation exchange capacity, are excessive when compared to University of Delaware phosphorus fertility index values. At the same time, the majority of monitoring wells samples analyzed phosphorus at non-detect levels. A few of the samples did indicate phosphorus concentrations above 1 mg/L. From this groundwater data, the general conclusion is that subsurface soils are removing phosphorus, and therefore the majority of the existing spray fields still have remaining capacity to accept additional phosphorus.

The Hydrogeologic Report included in the CRM examined the sodium, chloride, and total dissolved solids in the groundwater monitoring samples. Although some of the samples exceed their respective drinking water secondary standards, the levels are generally below the secondary standards. In addition, the levels are reported as being steady, to slightly increasing, from 2011-2015.

Based on the historic information from the 2017 CMR, and the need to meet performance standard nitrogen level 2 (annual average total nitrogen < 10 mg-N/L) and performance standard phosphorus level 2 (annual average total phosphorus < 8 mg-P/L, **Table 4.11** summarizes the projected effluent performance goals after the Phase 2 expansion is complete.

Table 4.11. Effluent Concentration Goals

Condition	Monthly Average Value	Units
BOD_5	<15	mg/L
TSS	<15	mg/L
NH_4-N	<1	mg/L
TN	<10	mg/L
TP	<8	mg/L
pH	5.5-9.0	
Sodium[1]	170	mg/L
Chlorides[1]	160	mg/L
Fecal Coliform	<200	MPN/100mL
Cadmium[2]	0.001	mg/L
Copper[2]	0.018	mg/L
Lead[2]	0.003	mg/L
Nickel[2]	0.013	mg/L
Zinc[2]	0.051	mg/L

[1] Any addition or removal of sodium or chlorides are incidental to the treatment process. The Effluent Concentrations are based on average measured for the period 2011-2016

[2] Maximum Annual Average Effluent Concentration 2011-2015

5 Wastewater Treatment Facility Process Design

5.1 Overview

A facility expansion and regional upgrades are proposed to meet the County's short and long-term growth objectives. The Phase 2 facility expansion will increase the plants rated capacity to 4.0 MGD. A future expansion to 6.0 MGD is planned, and the proposed upgrades will include provisions to facilitate this future expansion.

Overall facilities included in the Phase 2 Upgrade include:

1) New Screening Facility
2) New Grit Facility
    - Designed for a peak flow of 15 MGD, with the ability to expand to 22.1 MGD
3) New Biolac Aeration Lagoon Expansion
    - Two new aeration lagoons similar to the existing Biolac aeration lagoons
4) New Aeration Lagoon Distribution Box
5) New Clarifier Nos. 3 and 4
    - Similar design to existing Clarifiers No.1 and 2
6) New Pump and Blower Building
    - New building to house return and waste sludge pumps
7) Effluent Filtration
    - Designed to filter all effluent including for the future water re-use on adjacent properties
8) Irrigation Pump Station Facility
9) Regional Biosolids Facility
    - Biosolids facility sized for regional Sussex County and Rehoboth dewatered sludge
    - Facility to utilize indirect paddle-type drying unit
    - Truck unloading facility for dewatered cake
    - Unloading facility to integrate with existing storage facility and dryer facility
    - Regional Septage Receiving Station with dual units to provide redundancy

5.2 Process Description

The current IBRWF consists of an activated sludge process using cyclic aeration to provide BOD removal, nitrification and denitrification in a same lagoon. IBRWF is using the extended aeration system Biolac® as manufactured by Parkson.

Upstream of the Biolac lagoons is a dual mechanical screening facility. The screens remove large solids from the raw wastewater. A manual bar rack is located in a third channel. The Phase 2 Expansion will include a second screening facility, also containing two mechanical screens and a manual bar rack. The two screening facilities will operate in parallel.

The existing IBRWF does not currently include grit removal, and although the process does not require grit removal, inert solids will build up over time in the Biolac lagoons. The Phase 2 expansion will install a grit facility downstream of the screening facilities.

The current IBRWF has two liquid treatment lagoons that operated in parallel. Positive displacement blowers compress atmospheric air for use as process air. The process air is conveyed to long diffuser chains that are suspended across a geomembrane-lined earthen basin and supply oxygen to the wastewater. The process air is cycled on and off by actuated and automated valves at the end of each diffuser chain. Aerobic and anoxic conditions are created within the same lagoon. The suspended diffuser chains provide mixing when they are aerating. There is no other equipment located in the lagoon. IBRWF utilizes a Biolac wave oxidation system, manufactured by Parkson. The Phase 2 Expansion will add two additional Biolac lagoons.

The flow from the Biolac lagoons flow by gravity to two existing circular secondary clarifiers to separate settle-able solids from the treated wastewater, i.e. the secondary effluent. The settled solids collected in the clarifier underflow are pumped by the return activated sludge (RAS) pumping station to the influent distribution box. The Phase 2 Expansion will include two additional secondary clarifiers similar to the existing clarifiers, and a second RAS and WAS pumping station.

As the secondary effluent flows by gravity to the chlorine contact tank, sodium hypochlorite solution is added to provide disinfection. The treated effluent will then be pumped through cloth media filters to the two (2) existing storage lagoons.

Sludge is wasted from the system with waste activated sludge pumps located in the RAS pumping stations. The waste activated sludge (WAS) is stored in two waste sludge lagoons. The waste sludge lagoons are equipped with floating mixers and aerators.

Sludge is pumped from the sludge storage lagoons to the belt filter press for dewatering. Dewatered biosolids are currently permitted for land application on-site.

5.3 Process Flow Diagram

The process flow diagram is included in the Contract Drawings as M00.02.

5.4 Hydraulic Profile

The hydraulic profile is included in the Contract Drawings as M00.04.

5.5 Level of Treatment

As stated in Section 4 above, the IBRWF effluent goals include PSN-2 and PSP-2. See Section 4 for influent characteristics and detailed effluent characteristics.

A summary of the design parameters for the IBRWF Phase 2 Expansion are included in **Table 5.1**.

Table 5.1. Summary Design Parameters		
Facility	Quantity	Design Parameters
Headworks	• 2 Existing • 2 New	• Type – Automatic Mechanical Screen • Capacity Per Screen – 6.5 MGD Each • Openings – ¼ inch
Grit Facility	• 2 New	• Type – Induced Vortex • Capacity Per Tank – 7 MGD Each
Aeration Lagoons	• 2 Existing • 2 New	• Type – Biolac Aerated Lagoon • Volume Per Lagoon – 1.76 MG Each • Design SRT (Summer/Winter) – 39 / 46 days
Aeration Diffuser Capacity	• 416 Diffusers per Lagoon	• Type – Fine Bubble • AOR Per Basin – 213 lbs Oxygen / Hour / Basin
Blower Capacity	• 3 Existing • 2 New	• Type – Positive Displacement • Capacity per Blower – 2,200 SCFM Each • Discharge Pressure – 6.6 PSIG
Clarifiers	• 2 Existing • 2 New	• Type – Circular • Diameter – 85 FT • Sidewater Depth – 14 FT • Peak Surface Overflow Rate – 800 GPD/ sq ft • Peak Solids Loading Rate – 26.1 lbs/day/sq ft
Effluent Filtration	• 4 New	• Type – Cloth Media • 4.67 MGD Capacity, Each
Effluent Storage Lagoons	• 2 Existing	• Type – Lined Earthen Lagoons • Volume – 71 MG Total

5.6 Schematic of Pump Stations and Unit Processes

Flow from the IBRWF collection system is pumped by a network of lift stations and regional pump stations to the IBRWF headworks. The wastewater then flows through the IBRWF by gravity. The treated effluent can be is then pumped from the chlorine contact tank effluent through the filtration facility and into the two (2) storage lagoons.

The stored effluent is pumped from the storage lagoon Nos. 1 and 2 to spray irrigation rigs and the irrigation loop. The irrigation loop is planned for also providing irrigation water to adjacent agricultural lands not owned by the County.

See Drawing M00.02 for the storage lagoon schematic.

5.7 Basin/Tank Volumes

The volume of the two existing and two new aeration lagoons are included in **Table 5.2**.

Table 5.2. Aeration Lagoon Capacities	
Basin Name	Volume
	(Million Gallons)
Aeration Lagoon, ea	1.76
Aeration Lagoons (2), Existing total	3.52
Aeration Lagoons (4), Total with Phase 2	7.04

With four lagoons on line at the maximum month summer design flows of 4.0 MGD, the aeration lagoons will provide 42 hours of hydraulic retention time. At the summer design mixed liquor suspended solids (MLSS) of 2,950 mg/L, the system will provide a sludge age of 34 days during maximum month design flows, and 39 days at average summer design flows.

Details for the secondary clarifiers is included in **Table 5.3**.

Table 5.3. Secondary Clarifiers	
Existing/New Secondary Clarifiers	2 / 2
Diameter, ft	85
Side Water Depth, ft	14
Average Surface Overflow Rate, GPD/FT^2	190
Peak Surface Overflow Rate, GPD/FT^2	800
Average Solids Loading Rate, Lbs/Day/FT^2	12.2
Peak Solids Loading Rate, Lbs/Day/FT^2	26.1

Details regarding the chlorine contact tank are included in **Table 5.4**.

Table 5.4. Chlorine Contact Tank	
Existing Chlorine Contact Tank Volume, Gallons	150,000
Phase 2 Peak Hour Flow, MGD	13.0
Contact Time at Peak Hour Flow, Minutes	16

5.8 Storage Capacities

The volume of the two existing lagoons are included in **Table 5.5**.

Table 5.5. Storage Capacities	
Storage Lagoons	Volume
	(Million Gallons)
Storage Lagoon No. 1 (Existing)	31
Storage Lagoon No. 2 (Existing)	39
Total Storage Lagoons	71

The average influent flows to the IBRWF vary seasonally, therefore a winter and a summer design average flow have been developed. The distinction between winter and summer flows is significant to the spray irrigation and storage facilities. Information relevant to storage volume calculation from **Table 4.2** is provided in **Table 5.6**.

Table 5.6. Influent Wastewater Flows	
Condition	Flow Rate, mgd
Summer Average Month ADF	3.6
Winter Average Month ADF	2.8
Annual Average ADF	3.0

Storage has been more utilized more in the winter months, and therefore the winter average daily flow is used to determine the minimum storage volume required by IBRWF to meet Section 6.3.2.3.12.1 of the On Site Wastewater Regulations. The section states that 'municipal systems require a minimum of 45 days storage unless other disposal options are permitted'. Sussex County has discussed other disposal options with DNREC, and will pursue them separate from the IBRWF expansion. The winter average of 2.8 MGD times 45 days equals 126 million gallons of storage. **Figure 3.1** indicates the space reserved for an effluent storage lagoon that could provide the 45 days of storage if needed in the future.

5.9 Pumps, Blowers, and other equipment

The capacity and design criteria of the pumps, blowers and other equipment is indicated on Drawing M00.03 in the Contract Drawings.

5.10 Screening Facility

The Phase 2 Expansion will include a second screening facility, containing two mechanical screens and a manual bar rack. The two screening facilities will operate in parallel. Screenings that are collected will be washed, compacted and conveyed to a dumpster. Design information for the screening facility is included in **Table 5.7**.

Table 5.7. Screening Facility	
Number of Mechanical Screens	2
Flow Capacity per Screen, MGD	6.5
Screen Opening, Inches	¼"

5.11 Grit Facility

The Phase 2 expansion will install a grit facility downstream of the screening facilities. The grit facility will have two forced vortex grit removal in parallel, and a bypass channel. The grit that is collected will be washed and deposited into a dumpster. Design information for the grit facility information is included in **Table 5.8**.

Table 5.8. Grit Facility	
Number of Grit Tanks	2
Flow Capacity per Tank, MGD	7

5.12 Filtration Facility

A filtration facility will be added with Phase 2 to provide filtration for all the IBRWF effluent, including the re-use on adjacent agricultural lands not owned by the County. The filtration facility is sized to process up to 18.7 MGD of flow. Design information for the filtration facility is included in **Table 5.9**.

Table 5.9. Filtration Facility	
Number of Filters	4
System Flow Capacity, MGD	18.7
Filtration Degree, microns	10

5.13 Chemical Addition

Sodium hypochlorite solution is added upstream of the chlorine contact tank for disinfection to meet the spray irrigation permit. The system is existing and will not be modified with the Phase 2 expansion.

A polymer is added to the belt filter press influent to aid in floc formation and improve dewatering performance. The system is existing and will not be modified with the Phase 2 expansion.

5.14 Effluent Flow Metering

Secondary effluent is measured by a magnetic flow meter, flows are recorded in the process control system historian database. The influent flow is not measured.

5.15 Sludge Production and Disposal Process

Sludge production at the IBRWF will be affected by increased flows and loads that are planned to the facility. In addition, Sussex County plans to begin receiving septage, after not receiving septage for several years. The planned septage will be pumped to the sludge storage tanks and have minimal impact on the main liquid treatment process. To maintain sufficient oxygen in the sludge storage tanks, each sludge storage tank will each have two existing floating mixers (4 total) replaced with a 20 hp surface aerator.

The planned septage would increase sludge production by approximately 1,400 lbs dry solids per day at the 15,000 gallons per day of septage anticipated.

The total Phase 2 design sludge quantities including those expected from septage are presented in **Table 5.10**.

Table 5.10. Sludge Production

Condition	**Value**
Sludge Production Annual Average, lbs dry solids/day	4,800
Sludge Production Annual Average volume, gallons per day	72,000
Sludge Production Maximum Month Summer, lbs/day	6,750
Sludge Storage Tank Volume, Total, Million Gallons	3.35
Sludge HRT without decant at Annual Average, days	46.5

Sludge is dewatered on a 2-meter belt filter press with a design hydraulic capacity of 200 gpm. During the Phase 2 maximum month conditions, the belt filter press is anticipated to operate 8 hours a day 5 days a week.

The dewatered cake is currently permitted for on-site land application. A project to install a heat drying facility is being constructed and will produce Class A biosolids. The County plans to haul the dried solids to a landfill or use for beneficial re-use.

5.16 Overview of Process Control and Alarming

The IBRWF has an existing process control and alarming system that will be expanded for the Phase 2 expansion.

The control of the Biolac lagoon system is accomplished through the use of a manufacturer packaged control system. The lagoons cyclic aeration system and blowers are operated on a continual basis. Blower output is controlled manually, and blowers are brought on line depending on the dissolved oxygen measurements in the lagoons.

5.17 Calculations

5.17.1 Process Design Calculations

The IBRWF Phase 2 Expansion design utilized the BioWin® wastewater treatment process simulator software developed by EnviroSim of Hamilton, Ontario, Canada to estimate the process performance. The BioWin model was checked against actual recent plant performance. The parameters used in the BioWin model are included in the annual average conditions model run report included in Appendix A.

The process aeration requirements were verified using an Excel spreadsheet included in Appendix B.

The sizing of the secondary clarifiers and RAS and WAS pumping rates was completed in the Phase 1 design, with Phase 2 adding two similar secondary clarifiers along with an associated pumping station.

The design criteria for the facilities included in Phase 2 are detailed in the IBRWF Phase 2 Expansion Technical Memorandum, 2017.

The proposed four (4) parallel lagoon system was evaluated using the activated sludge model in the BioWin® Process Simulator (v5.0) with the design maximum month design conditions (both summer at 20C and winter at 12C), assuming that all lagoons are in service, and with average summer conditions with one lagoon out of service. The BioWin® model configuration is depicted in **Figure 5.1**, and a summary of the modeling results are summarized in **Table 5.11** and **5.12**.

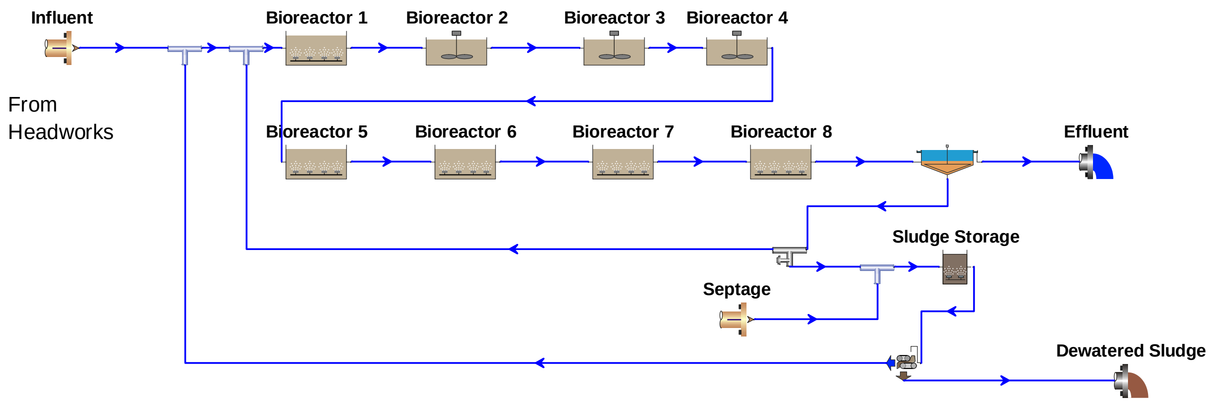


Figure 5.1 Aerated Lagoon Process Configuration (BioWin®).

Table 5.11. BioWin Modeling Results Summary			
Secondary Clarifier Effluent	Average Month, Summer with One Lagoon Out of Service	Maximum Month, Summer	Annual Average Month, Winter Temp
Flow	3.8 MGD	4.2 MGD	3.0 MGD
MLSS	3,000 mg/L	2,900 mg/L	3,500 mg/L
BOD_5	1.0 mg/L	1.0 mg/L	0.9 mg/L
TSS	3.0 mg/L	2.8 mg/L	3.5 mg/L
Ammonia	0.1 mg/L	0.3 mg/L	0.1 mg/L
TKN, Filtered	1.9 mg/L	2.8 mg/L	2.2 mg/L
Nitrate/Nitrite	0.6 mg/L	4.8 mg/L	3.4 mg/L
Total Nitrogen	2.6 mg/L	7.7 mg/L	5.8 mg/L
WW Temperature	20 °C	20 °C	12 °C

Table 5.12. BioWin Modeling Aeration Requirements			
	AOR Per Lagoon (lbs O_2/day)	SOR Per Lagoon (lbs O_2/day)	Air Flow per Lagoon (scfm)
Maximum Month	4,510	9,975	2,150
Average Month	2,980	6,580	1,450

5.17.2 Wastewater Disposal System Sizing

The wastewater disposal system was sized to provide sufficient capacity to eliminate the effluent storage lagoons (71 MG) within 90 days during Phase 2 annual average influent flows of 3.0 MGD. See the water balance spreadsheet in Section 7.

5.17.3 Dosing

Sodium hypochlorite solution (nominal 12.5wt% NaOCl) is stored in an existing 7,000 gallon tank and is dosed to the RAS piping for control of filamentous, and upstream of the chlorine contact tank for disinfection.

For control of filamentous a rate of 1-2 lbs of chlorine per 1,000 lbs of mixed liquor suspended solids per day is recommended. Hypochlorite solution will be piped to the Phase 2 proposed Pump and Blower Building No. 2 for this purpose, similar to the existing system.

Chlorine dosing for disinfection of the secondary effluent varies based on the wastewater characteristics but generally varies between 5 and 10 mg/L. The chlorine dosing and contact tank are not being modified for Phase 2. At the Phase 2 peak hour flow of 13 MGD, the existing 150,000 gallon chlorine contact tank will provide 16 minutes of contact time.

For Phase 2, provisions will be included to dose hypochlorite solution to the tertiary effluent, downstream of the pressure filters. A dose of 2-10 mg/L is recommended to maintain daily average fecal coliform concentrations below 200 colonies per 100 mL. Considering the IBRWF effluent is normally disinfected to maintain a monthly average fecal coliform concentration below 200 colonies per 100 mL, the hypochlorite system is expected to only be used sporadically to reduce biofilm growth in the distribution piping.

A liquid polymer is added to the sludge feed to the dewatering facility (belt filter press) to cause suspended solids to flocculate to improve the dewatering efficiency. The polymer and dewatering facility is not being modified in Phase 2.

5.17.4 Sludge Production

Sludge production was estimated using the BioWin® wastewater treatment process simulator software developed by EnviroSim of Hamilton, Ontario, Canada.

5.18 Effluent Disposal System

5.18.1 Disposal System Type

The IBRWF uses spray irrigation for effluent disposal. The Phase 2 Expansion will include the development of two new irrigation fields, 'C' and 'D'. These fields are wooded with primarily pine trees. A fixed head irrigation system will be installed to spray on the trees.

5.18.2 Effluent Conveyance and Distribution

See **Figure 2.2** for a site plan of the planned irrigation system.

5.18.3 Flow Metering and Recordation

Flow pumped from the Storage Lagoon No. 2 by the Filtered Irrigation Pump Station is measured by a magnetic flow meter. The flow will be recorded in the Process Control System data historian database. See flow meter location on Drawing M09.01 in the Drawings.

5.18.4 Disinfection

There are provisions to dose sodium hypochlorite solution to the Filtered Irrigation Pump Station discharge. The need to add hypochlorite will be as needed to maintain a fecal coliform concentration less than 200 colonies/100 mL at the discharge of the pump station.

6 Soil Report

The Soil Investigations Report for the Inland Bays Regional Wastewater Treatment Expansion was previously submitted to DNREC by Accent Environmental, llc, dated December 5, 2016.

7 Water Balance

A water balance was developed for all existing spray irrigation fields and the Expansion Fields C and D, and considered the total treatment capacity, and the existing storage lagoons.

The IBRWF currently utilizes 8 spray fields, and will be developing two more during the Phase 2 expansion. The application rate varies depending on the field from 1 to 2.5 inches per week. The water balance utilizes an acreage weighted average of the weekly application rates, which is shown in **Table 7.1**.

Table 7.1. Spray Field Weighted Average Application Rate

Parcel	**Status**	**Wetted Area**	**Spray Rate**	**Effluent Disposal Capacity**	**Weighted Average Rate Calc**
		(Acres)	**(Inches/ Week)**	**(MGD)**	**(Inches/ Week)**
South Field	Existing	103	1.86	0.74	0.27
North Field	Existing	103	1.86	0.74	0.27
North Burton Field	Existing	52	1.5	0.30	0.11
South Burton Field	Existing	46.9	1	0.18	0.07
North Hetti-Lingo	Existing	47.5	1	0.18	0.07
South Hetti-Lingo	Existing	30.48	2	0.24	0.08
East Hetti-Lingo	Existing	34.46	1	0.13	0.05
West Hetti-Lingo	Existing	20.16	2	0.16	0.06
Area C (north of Inland Bays Rd)	Proposed	70.7	2.5	0.87	0.27
Area D (south of Inland Bays Rd)	Proposed	149.2	2.5	1.84	0.57
Total IBRWF Phase 2	**---**	**657.4**	**---**	**5.4**	**1.80**

The basis for the water balance is presented in **Table 7.2**.

Table 7.2. Water Balance Scenarios	
Parameter	**Phase 1 and 2 Facilities**
Treatment Flow, Average Month, MGD	3
Spray Irrigation Fields, Wetted Area, Acres	657.4
Weighted Average Application Rate, Inches/week	1.8
Storage Lagoon Volume, MG	71

The water balance calculations assume the storage lagoon(s) are full at the end of April. The goal is to empty the storage lagoons while also disposing average flows within 90 days. In the full Phase 2 expansion scenario the irrigation fields are sufficient to meet this requirement. Water balance calculations utilizing the DNREC provided spreadsheet are presented in **Table No. 7.3**. The Excel file will be included on a CD with the permit application.

STORAGE	**Units**	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	SUM
Volume Generated (line 14)	gal/mo	93	84	93	90	93	90	93	93	90	93	90	93	1095
Volume Irrigated (line 17)	gal/mo	85	73	82	113	140	159	171	135	138	114	98	82	1390
Volume added from Precipitation to system on all treatment and storage lagoons (calculated using line 9 and the 5-Year Return Period Monthly Precipitation (Exhibit K-K)")	gal/mo	3.00	2.80	3.57	2.87	3.19	3.25	4.02	5.23	3.31	3.44	2.93	3.31	41
Volume lost due to Evaporation from system from all treatment and storage lagoons (calculated using line 9)	gal/mo	0.06	0.06	0.45	1.15	2.10	3.06	3.51	3.12	2.29	1.21	0.57	0.13	18
Volume Stored	gal/mo	10.77	13.57	14.54	-20.98	-46.41	-68.92	-77.33	-40.04	-46.67	-18.49	-6.06	14.60	-271
Cumulative Volume Stored	gal/mo				71	25	(44)				-	-	-	

Table No. 7.3 IBRWF Design Phase 2 Expansion Water Balance

8 Nitrogen Balance

Two separate nitrogen balances were developed. A nitrogen balance for the Phase 2 Expansion Fields C and D, and considering only the additional treatment capacity. A second nitrogen balance was developed for all existing spray irrigation fields and the Expansion Fields C and D, and considered the total treatment capacity. The basis for the two nitrogen balance scenarios are presented in **Table 8.1**.

Table 8.1. Nitrogen Balance Scenarios

Parameter	Phase 1 and 2 Facilities
Treatment Flow, Average Month, MGD	3
Spray Irrigation Fields, Wetted Acres	657.4
Crop Type	Summer : Corn Fall/Winter : Cover Crop Not Harvested

In the Phase 1 and 2 scenarios, corn is used as the only crop grown on all of the fields. Considering the crops and trees, that are planned to be grown on the spray fields, utilizing corn in the nitrogen balance will provide the most conservative estimate for nitrogen in the percolate. In addition, the design nitrogen balances presented here assume the winter cover crop will be plowed under in the spring. This again provides a more conservative approach. See the Section 9 – Vegetative Management Plans for actual crop planning for the existing spray fields. The expansion fields C and D will remain wooded with selective removal as needed.

The goal is to maintain the monthly total nitrogen content in the percolate less than 10 mg/L. The treatment process is sufficient to meet this requirement. Nitrogen balance calculations utilizing the DNREC provided spreadsheet are represented in **Table 8.2**. The Excel file will be included on a CD with the permit application.

12	Parameter	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	SUM
13	**Treatment Capacity**														
14	Influent Flow	million gal/mo	93	84	93	90	93	90	93	93	90	93	90	93	1095
15															
16	**Hydraulic Spray Application**														
17	Effluent Flow	million gal/mo	85	73	82	113	140	159	171	135	138	114	98	82	1390
18		gal/acre	129535	111306	124104	171431	213712	242031	259874	205566	209446	172981	149707	124104	2113798
19	Calendar days per month	days/mo	31	28	31	30	31	30	31	31	30	31	30	31	365
20	Spray days per month	days/mo	20.3	19.5	22.2	21.5	21.3	21.3	21.2	22.2	20.3	21.2	19.5	20.8	251
21	Spray hydraulic application rate	in/mo	4.77	4.10	4.57	6.31	7.87	8.91	9.57	7.57	7.71	6.37	5.51	4.57	78
22	Spray hydraulic application rate	in/week	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	N/A
23															
24	**Total Nitrogen Application**														
25	Total nitrogen in spray effluent	mg/L	10	10	10	10	10	10	10	10	10	10	10	10	
26	Total nitrogen in spray effluent	lb/acre-mo	10.8	9.3	10.4	14.3	17.8	20.2	21.7	17.1	17.5	14.4	12.5	10.4	176.3
27	Total nitrogen applied as commercial fertilizer	lb/acre-mo	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28	Total nitrogen applied as biosolids	lb/acre-mo	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29	Total nitrogen due to precipitation	lb/acre-mo	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	5.0
30	Total nitrogen due to fixation	lb/acre-mo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	Total nitrogen applied	lb/acre-mo	11.2	9.7	10.8	14.7	18.2	20.6	22.1	17.6	17.9	14.8	12.9	10.8	181.3
32															
33	**Ammonia Application**														
34	Ammonia in spray effluent	mg/L	1	1	1	1	1	1	1	1	1	1	1	1	
35	Total ammonia application	lb/acre-mo	1.1	0.9	1.0	1.4	1.8	2.0	2.2	1.7	1.7	1.4	1.2	1.0	17.6
36															
37	**Nitrogen Utilization**														
38	Plant nitrogen uptake (see below)														
39	Summer Crop ****	lb/acre-mo				3.1	23.3	40.3	52.7	32.6	3.1				155.0
40	Winter Cover Crop ***	lb/acre-mo													
41	Denitrification (15% of line 26)	lb/acre-mo	1.6	1.4	1.6	2.1	2.7	3.0	3.3	2.6	2.6	2.2	1.9	1.6	
42	Ammonia Volitilization (5% of line 35)	lb/acre-mo	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
43	Total nitrogen consumed	lb/acre-mo	1.7	1.4	1.6	5.3	26.0	43.4	56.1	35.2	5.8	2.2	1.9	1.6	
44															
45	**Percolate Nitrogen Content**														
46	Total nitrogen in percolate (line 31 minus line 43)	lb/acre-mo	9.5	8.3	9.2	9.4	-7.8	-22.8	-34.0	-17.6	12.1	12.6	11.0	9.2	
47	Total nitrogen in percolate	lb/mo	6275.2	5430.7	6023.6	6178.3	-5109.7	-15006.5	-22331.8	-11601.0	7939.5	8288.1	7209.8	6023.6	
48															
49	**Percolate Volume**														
50	Spray Hydraulic Application (line 21)	in/mo	4.77	4.10	4.57	6.31	7.87	8.91	9.57	7.57	7.71	6.37	5.51	4.57	
51	Climatoligical Normal Precipitation (Exhibit K-K)	in/mo	3.30	3.20	4.10	3.20	3.40	3.60	3.90	5.30	3.60	3.50	3.10	3.60	
52	Total Hydraulic Loading	in/mo	8.07	7.30	8.67	9.51	11.27	12.51	13.47	12.87	11.31	9.87	8.61	8.17	
53	Thornwaite Potential Evapotranspiration (Exhibit J-J)	in/mo	0.10	0.10	0.70	1.80	3.30	4.80	5.50	4.90	3.60	1.90	0.90	0.20	
54	Percolate (line 52 minus line 53)	in/mo	7.97	7.20	7.97	7.71	7.97	7.71	7.97	7.97	7.71	7.97	7.71	7.97	
55	Percolate volume	gal/mo	142282192	128512947	142282192	137692444	142282192	137692444	142282192	142282192	137692444	142282192	137692444	142282192	1675258063
56															
57	**Percolate Nitrogen Concentration**														
58	Total nitrogen in percolate (line 47)	lb/mo	6,275	5,431	6,024	6,178	-5,110	-15,007	-22,332	-11,601	7,940	8,288	7,210	6,024	
59	Percolate volume (line 55)	gal/mo	142282192	128512947	142282192	137692444	142282192	137692444	142282192	142282192	137692444	142282192	137692444	142282192	
60	Total nitrogen concentration in percolate	lb/MG	44	42	42	45	-36	-109	-157	-82	58	58	52	42	
61	**Nitrogen concentration in percolate**	**mg/L**	**5.3**	**5.1**	**5.1**	**5.4**	**0.0**	**0.0**	**0.0**	**0.0**	**6.9**	**7.0**	**6.3**	**5.1**	

Table Nos. 8.2 IBRWF Design Phase 2 Expansion Nitrogen Balance

9 Vegetative Management Plan

A vegetative management plan extending through calendar year 2021 was included in the CMR for the existing spray fields submitted in 2017, see **Table 9.1**. It is expected the crop pattern indicated will continue past 2022 as well.

The expansion fields C and D are currently wooded with primarily pine trees. Access roads will be cleared to allow for the installation and maintenance of the irrigation piping and spray heads. Otherwise the existing foliage will remain undisturbed.

As was recognized in the 2017 CMR, the application of chemical fertilizers must be used sparingly, and the application should be spread out to avoid exceeding the 10 mg/L nitrogen concentrations in the percolate.

Table 9.1. Vegetative Management Plan

Field	**2019**	**2019**	**2020**	**2020**	**2021**	**2021**	**2022**	**2022**
	Spring	**Fall**	**Spring**	**Fall**	**Spring**	**Fall**	**Spring**	**Fall**
North	Soybean	Barley	Corn	Wheat	Soybean	Barley	Corn	Wheat
South	Corn	Wheat	Soybean	Barley	Corn	Wheat	Soybean	Barley
North Burton	Soybean	Barley	Corn	Wheat	Soybean	Barley	Corn	Wheat
South Burton	Soybean	Barley	Corn	Wheat	Soybean	Barley	Corn	Wheat
North Hettie Lingo	Corn	Wheat	Soybean	Barley	Corn	Wheat	Soybean	Barley
South Hettie Lingo	Corn	Wheat	Soybean	Barley	Corn	Wheat	Soybean	Barley
East Hettie Lingo	Corn	Wheat	Soybean	Barley	Corn	Wheat	Soybean	Barley
West Hettie Lingo	Corn	Wheat	Soybean	Barley	Corn	Wheat	Soybean	Barley
‘C’	Pine	Pine	Pine	Pine	Pine	Pine	Pine	Pine
‘D’	Pine	Pine	Pine	Pine	Pine	Pine	Pine	Pine

10 Constituent Loading Rates

10.1 Phosphorus

A design phosphorus balance was developed to demonstrate a conservative scenario. Based on recent crop yields (2011 to 2015) indicated in the 2017 CMR for the existing fields, soybeans generally remove a lower level of phosphorus when compared to corn. Soybean yields were as low as 37.3 bushels per acre during 2011 - 2015. Using a phosphorus removal rate of 0.84 lbs P_2O_5 per bushel of soybeans, equates to 31.3 lbs P_2O_5 removed per acre.

The design phosphorus concentration in the effluent is 8 mg/L. At an irrigation rate of 2.5 inches per week (the maximum of any of the fields), phosphorus would be applied at a rate of 18 lbs / acre, which is less than the harvested crops would remove.

From the Soil Investigation Report for the IBRWF Spray Expansion, dated December 2016 by Accent Environmental, llc, found the following for the expansion fields that were studied :

“Soil phosphorous concentrations in the P_2O_5 form ranged from 4.6 to 133 mg kg-1. This range is skewed due to the presence of three sample outliers that had concentrations of 87, 117 and 133 mg kg-1. If those three samples are not considered, P_2O_5 concentrations ranged from 4.6 to 27.5 mg kg-1 and would be considered very low.”

The SIR was submitted under separate cover, and should be consulted for additional details.

10.2 Metals

From the Soil Investigation Report for the IBRWF Spray Expansion, dated December 2016 by Accent Environmental, llc, found the following for the expansion fields that were studied:

“The Total cadmium (Cd), nickel (Ni) and lead (Pb) concentrations were well below total maximum soil concentrations permitted by the US EPA; 17 mg kg-1, 8 mg kg-1 and 188 mg kg-1 respectively. Cadmium and Ni were below detection levels and Pb concentrations ranged from below detection level to 9 mg kg-1.”

“The micronutrient zinc (Zn) was present in very low to low concentrations (1.6 to 10.1 mg kg-1) across the sites and is expected given the nature of the soils. Zinc is readily available in the soil solution when pH is <6. However, due to the low CEC levels and sandy textures, much plant available Zn is leached from the soil profile.”

“Copper (Cu) and boron (B) concentrations were very low to low across the study sites; 0.1 to 0.7 mg kg-1 and ~0.1 mg kg-1, respectively. The low pH of the soils is a factor in these low levels since Cu and B are less available in the soil solution when pH drops below 5. Low CEC levels and sandy soil textures further contribute to low concentrations of these micronutrients.”

The SIR was submitted under separate cover and should be consulted for additional details.

10.3 Land Limiting Constituent

Nitrogen and Phosphorus balances for the spray irrigation operation are discussed elsewhere in this DER, and indicate spray irrigation will not cause the fields to exceed permit limits. The introduction of metals, lead, zinc, copper, nickel and cadmium, to the spray fields, were evaluated in the IBRWF 2017 CMR.

In DNREC regulations (Exhibit HH), for a site with a soil cation exchange capacity of 0-5 meq/100g (as noted in the 1989 DDR for this facility), the permitted cumulative limit for metal application rates to soils used for production of food-chain crops are given in **Table 10.1**.

Table 10.1. Application Rate Limits for Metals	
Constituent	**Application Rate Limit**
	Pounds per Acre
Lead	500
Zinc	250
Copper	125
Nickel	125
Cadmium	4.4

Using the following:

- Design site loading for 2019 and forward calculated using
    1.) The effluent metal concentrations as indicated in **Table 4.11,**
    2.) Spray irrigation rate annual average for the existing fields is 1.5 MGD,
    3.) Spray irrigation rate annual average of 1.5 MGD for the Expansion Fields C and D,
    4.) For existing fields, the years already in use are subtracted from that determined using the design site loading rates,

the site life remaining was calculated and is shown in **Table 10.2**.

Table 10.2. Site Life Remaining for Metals

Field	Constituent	Design Loading Rate[1]	Application Rate Limit	Allowed	Years Remaining
		Lbs/Year	Pounds per Acre	Pounds	
North Field	Lead	3.26	500	51,500	15,761
In Use for 25 years	Zinc	55.5	250	25,750	439
103 Acres	Copper	19.6	125	12,875	633
	Nickel	14.1	125	12,875	886
	Cadmium	1.09	4.4	453	392
South Field	Lead	3.26	500	51,500	15,761
In Use for 25 years	Zinc	55.5	250	25,750	439
103 Acres	Copper	19.6	125	12,875	633
	Nickel	14.1	125	12,875	886
	Cadmium	1.09	4.4	453	392
North Burton Field	Lead	1.65	500	26,000	15,778
In Use for 8 years	Zinc	28.0	250	13,000	456
52 Acres	Copper	9.88	125	6,500	650
	Nickel	7.14	125	6,500	903
	Cadmium	0.549	4.4	229	409
South Burton Field	Lead	1.33	500	20,950	15,780
In Use for 6 years	Zinc	22.6	250	10,475	458
41.9 Acres	Copper	7.96	125	5,238	652
	Nickel	5.75	125	5,238	905
	Cadmium	0.442	4.4	184	411

Table 10.2. Site Life Remaining for Metals					
Field	**Constituent**	**Design Loading Rate[1]**	**Application Rate Limit**	**Allowed**	**Years Remaining**
		Lbs/Year	Pounds per Acre	Pounds	
North Hettie Field	Lead	1.50	500	23,750	15,780
In Use for 6 years	Zinc	25.6	250	11,875	458
47.5 Acres	Copper	9.03	125	5,938	652
	Nickel	6.52	125	5,938	905
	Cadmium	0.501	4.4	209	411
South Hettie Field	Lead	0.965	500	15,240	15,781
In Use for 5 years	Zinc	16.4	250	7,620	459
30.48 Acres	Copper	5.79	125	3,810	653
	Nickel	4.18	125	3,810	906
	Cadmium	0.322	4.4	134	412
East Hettie Field	Lead	1.09	500	17,230	15,781
In Use for 5 years	Zinc	18.6	250	8,615	459
34.46 Acres	Copper	6.55	125	3,810	653
	Nickel	4.73	125	3,810	906
	Cadmium	0.364	4.4	152	412
West Hettie Field	Lead	0.639	500	10,080	15,781
In Use for 5 years	Zinc	10.9	250	5,040	459
20.16 Acres	Copper	3.83	125	2,520	653
	Nickel	2.77	125	2,520	906
	Cadmium	0.213	4.4	89	412

Table 10.2. Site Life Remaining for Metals

Field	Constituent	Design Loading Rate[1]	Application Rate Limit	Allowed	Years Remaining
		Lbs/Year	Pounds per Acre	Pounds	
Expansion Fields C and D	Lead	13.7	500	140,000	10,026
In Use for 0 years	Zinc	233	250	70,000	236
219.9 Acres	Copper	82.2	125	35,000	334
	Nickel	59.4	125	5,238	463
	Cadmium	4.57	4.4	1,232	211

[1] Design Loading for 2019 and forward using concentrations in **Table 4.11** and 1.5 MGD applied to existing fields, and 1.5 MGD applied to expansion fields

11 Project Phasing

The Inland Bays RWF Phase 1 expansion was constructed in 2009 giving the plant it's existing permitted capacity of a nominal 2.0 MGD. The ultimate buildout plant capacity of a nominal 6.0 MGD can be achieved with adding liquid process facilities and developing more spray irrigation fields for effluent disposal. The proposed Phase 2 Plant Expansion includes the plant process upgrades and irrigation field expansion described within this report to add a nominal 2.0 MGD of treatment capacity for a total nominal maximum month plant capacity of 4.0 MGD.

Inland Bays Regional Wastewater Facility, Phase 2 Expansion
Design Engineering Report
Sussex County

APPENDIX A

BioWin Report

BioWin user and configuration data

Project details

Project name: Phase 2 Annual Average Conditions | **Project ref.: BW1**

Plant name: Inland Bays Regional WW Facility | **User name: dnixson**

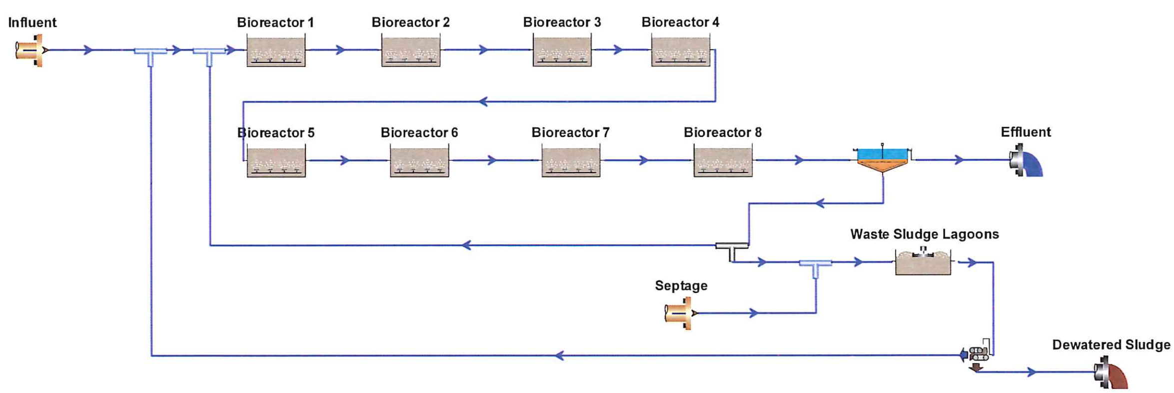
Created: 9/18/2015 | **Saved: 10/18/2018**

Steady state solution

SRT #0: 35.42 days

Temperature: 20.0°C

Flowsheet



Configuration information for all Bioreactor units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Bioreactor 1	0.8800	9803.2413	12.000	2221
Bioreactor 2	0.8800	9803.2413	12.000	2221
Bioreactor 3	0.8800	9803.2413	12.000	2221
Bioreactor 4	0.8800	9803.2413	12.000	2221
Bioreactor 5	0.8800	9803.2413	12.000	2221
Bioreactor 6	0.8800	9803.2413	12.000	2221
Bioreactor 7	0.8800	9803.2413	12.000	2221
Bioreactor 8	0.8800	9803.2413	12.000	2221

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
Bioreactor 1	2.0
Bioreactor 2	0.2
Bioreactor 3	0.2
Bioreactor 4	0.2
Bioreactor 5	0.3
Bioreactor 6	0.3
Bioreactor 7	0.3
Bioreactor 8	0.5

Aeration equipment parameters

Element name	k1 in C = k1(PC)^ 0.25 + k2	k2 in C = k1(PC)^ 0.25 + k2	Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)]	Area of one diffuser	Diffuser mounting height	Min. air flow rate per diffuser	Max. air flow rate per diffuser	'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2
Bioreactor 1	2.5656	0.0432	0.8200	0.4413	0.2500	12.0000	240.0000	3.0000	0	0
Bioreactor 2	2.5656	0.0432	0.8200	0.4413	0.2500	12.0000	240.0000	3.0000	0	0
Bioreactor 3	2.5656	0.0432	0.8200	0.4413	0.2500	12.0000	240.0000	3.0000	0	0
Bioreactor 4	2.5656	0.0432	0.8200	0.4413	0.2500	12.0000	240.0000	3.0000	0	0
Bioreactor 5	2.5656	0.0432	0.8200	0.4413	0.2500	12.0000	240.0000	3.0000	0	0
Bioreactor 6	2.5656	0.0432	0.8200	0.4413	0.2500	12.0000	240.0000	3.0000	0	0
Bioreactor 7	2.5656	0.0432	0.8200	0.4413	0.2500	12.0000	240.0000	3.0000	0	0
Bioreactor 8	2.5656	0.0432	0.8200	0.4413	0.2500	12.0000	240.0000	3.0000	0	0

Configuration information for all BOD Influent units

Operating data Average (flow/time weighted as required)

Element name	Influent	Septage
Flow	3	0.015
Total Carbonaceous BOD mgBOD/L	247.00	3374.00
Volatile suspended solids mg/L	250.00	3000.00
Total suspended solids mg/L	286.00	15000.00
Total Kjeldahl Nitrogen mgN/L	52.00	472.00
Total P mgP/L	9.00	500.00

Nitrate N mgN/L	0	0
pH	7.30	7.30
Alkalinity mmol/L	6.00	6.00
Calcium mg/L	80.00	80.00
Magnesium mg/L	15.00	15.00
Dissolved O2 mg/L	0	0

Element name	Influent	Septage
Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD]	0.1600	0.1600
Fac - Acetate [gCOD/g of readily biodegradable COD]	0.1500	0.1500
Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD]	0.9484	0.8331
Fus - Unbiodegradable soluble [gCOD/g of total COD]	0.0500	0.0500
Fup - Unbiodegradable particulate [gCOD/g of total COD]	0.1300	0.1300
Fna - Ammonia [gNH3-N/gTKN]	0.6600	0.6600
Fnox - Particulate organic nitrogen [gN/g Organic N]	0.5000	0.5000
Fnus - Soluble unbiodegradable TKN [gN/gTKN]	0.0200	0.0200
FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD]	0.0350	0.0350
Fpo4 - Phosphate [gPO4-P/gTP]	0.5000	0.5000
FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD]	0.0110	0.0110
FZbh - OHO COD fraction [gCOD/g of total COD]	0.0200	0.0200
FZbm - Methylotroph COD fraction [gCOD/g of total COD]	1.000E-4	1.000E-4
FZaob - AOB COD fraction [gCOD/g of total COD]	1.000E-4	1.000E-4
FZnob - NOB COD fraction [gCOD/g of total COD]	1.000E-4	1.000E-4
FZaao - AAO COD fraction [gCOD/g of total COD]	1.000E-4	1.000E-4
FZbp - PAO COD fraction [gCOD/g of total COD]	1.000E-4	1.000E-4
FZbpa - Propionic acetogens COD fraction [gCOD/g of total COD]	1.000E-4	1.000E-4
FZbam - Acetoclastic methanogens COD fraction [gCOD/g of total COD]	1.000E-4	1.000E-4
FZbhm - H2-utilizing methanogens COD fraction [gCOD/g of total COD]	1.000E-4	1.000E-4
FZe - Endogenous products COD fraction [gCOD/g of total COD]	0	0

Configuration information for all Effluent units

Configuration information for all Ideal clarifier units

Physical data

Element name	Volume[Mil. Gal]	Area[ft2]	Depth[ft]
Ideal clarifier5	1.2000	1.146E+4	14.000

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Ideal clarifier5	Flow paced	100.00 %

Element name	Average Temperature	Reactive	Percent removal	Blanket fraction
Ideal clarifier5	Uses global setting	No	99.95	0.05

Configuration information for all Sidestream Mixer units

Physical data

Element name	Volume[Mil. Gal]	Area[ft2]	Depth[ft]
Sidestream Mixer15	0	N/A	N/A
Sidestream Mixer16	0	N/A	N/A
Sidestream Mixer29	0	N/A	N/A

Configuration information for all Dewatering unit units

Physical data

Element name	No Volume
Dewatering unit4	0

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Dewatering unit4	Ratio	0.01

Element name	Percent removal
Dewatering unit4	100.00

Configuration information for all Sludge units

Configuration information for all Splitter units

Physical data

Element name	Volume[Mil. Gal]	Area[ft2]	Depth[ft]
Splitter6	0	N/A	N/A

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Splitter6	Flowrate [Side]	0.07

Configuration information for all Bioreactor (surface aerators) units

Physical data

Element name	Volume[Mil. Gal]	Area[ft2]	Depth[ft]
Waste Sludge Lagoons	3.4000	3.030E+4	15.000

Operating data Average (flow/time weighted as required)

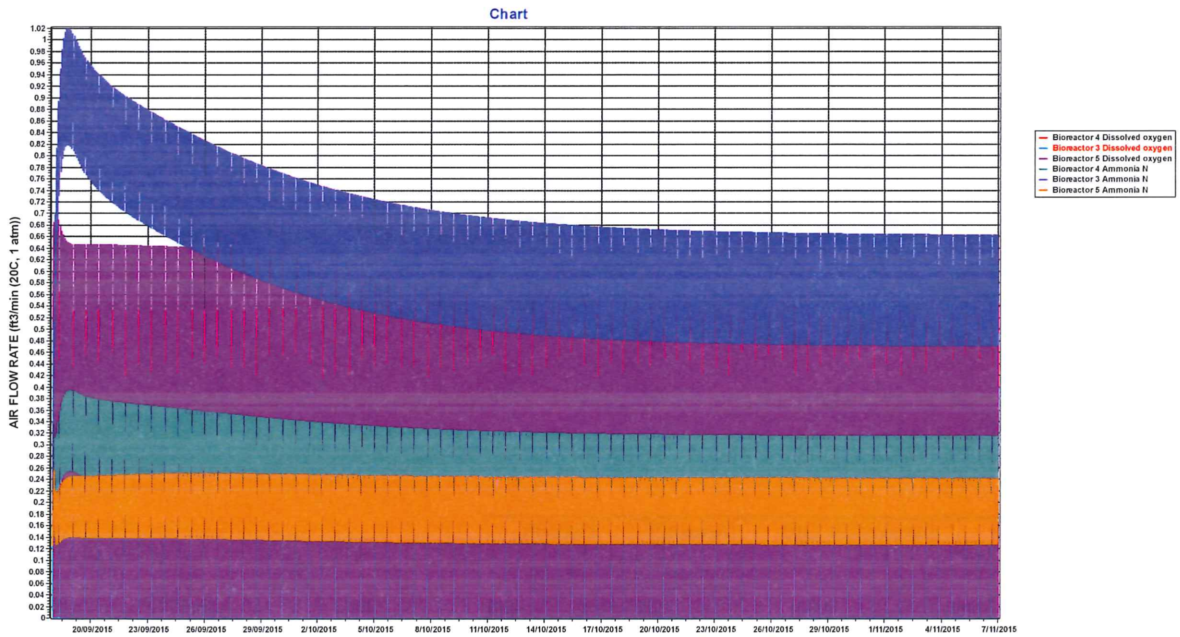
Element name	Average Power supply rate [hp]
Waste Sludge Lagoons	15.0

Aeration equipment parameters

Element name	Surface aerator Std. oxygen transfer rate [lb O /(hp hr)]	Maximum power per rotor [hp]
Waste Sludge Lagoons	2.4670	26.8097

BioWin Album

Album page - Page 1



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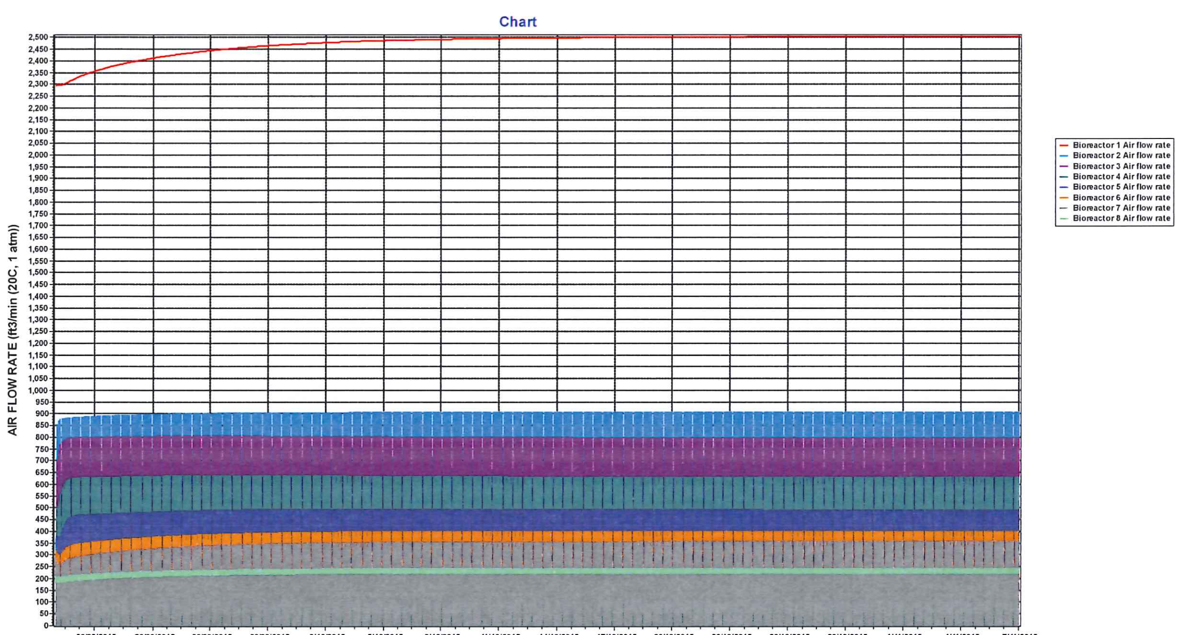

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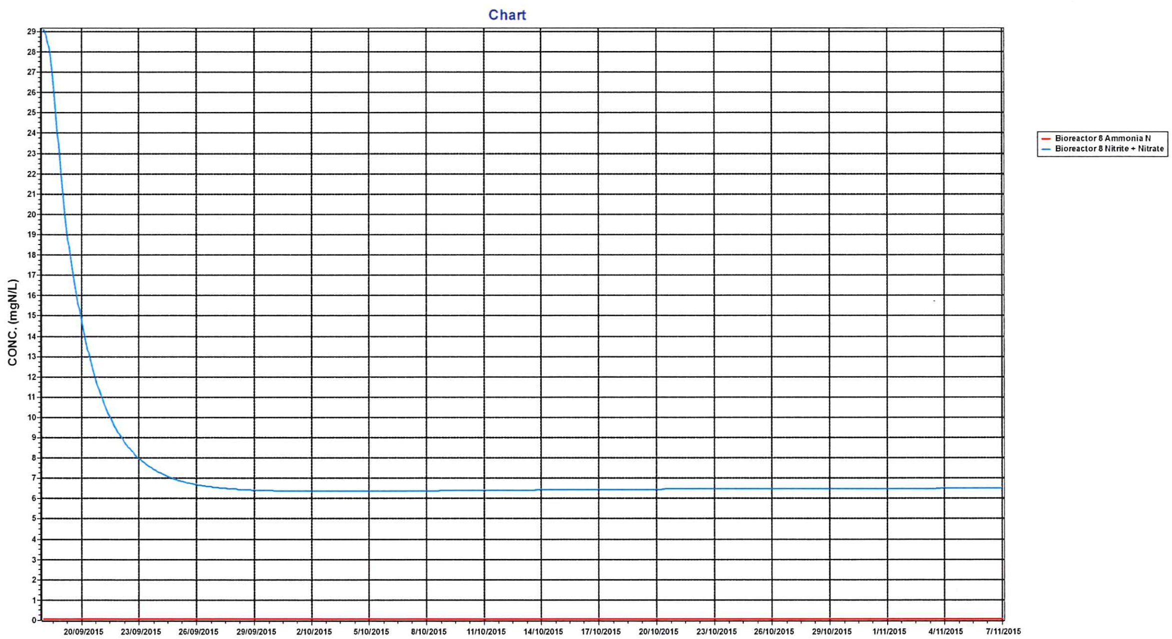

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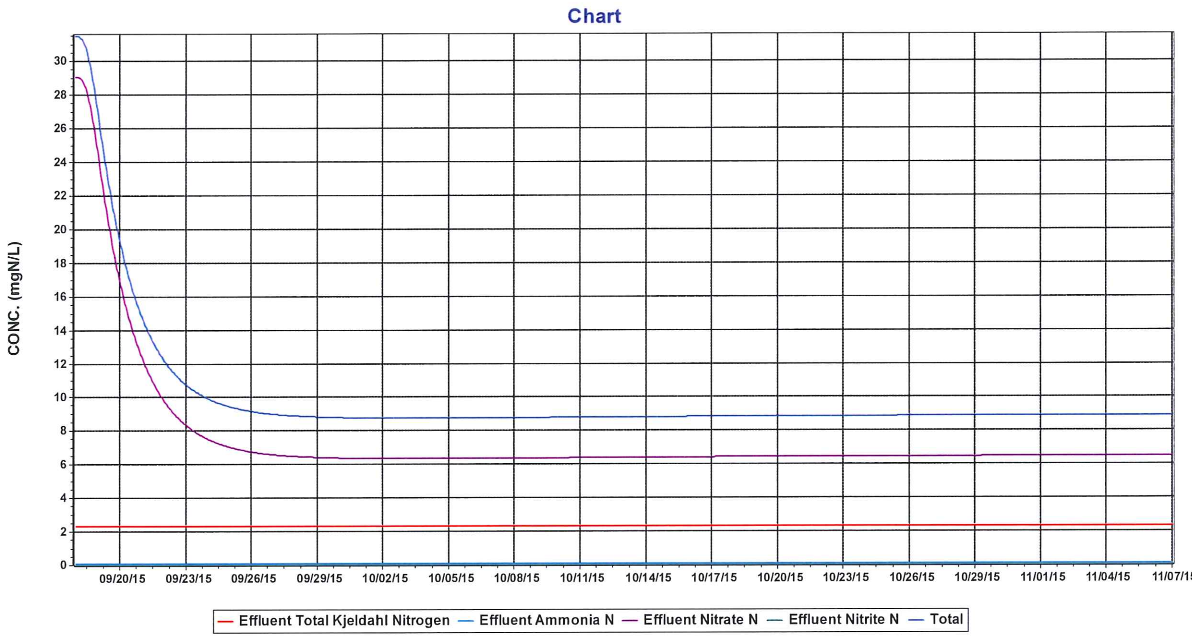

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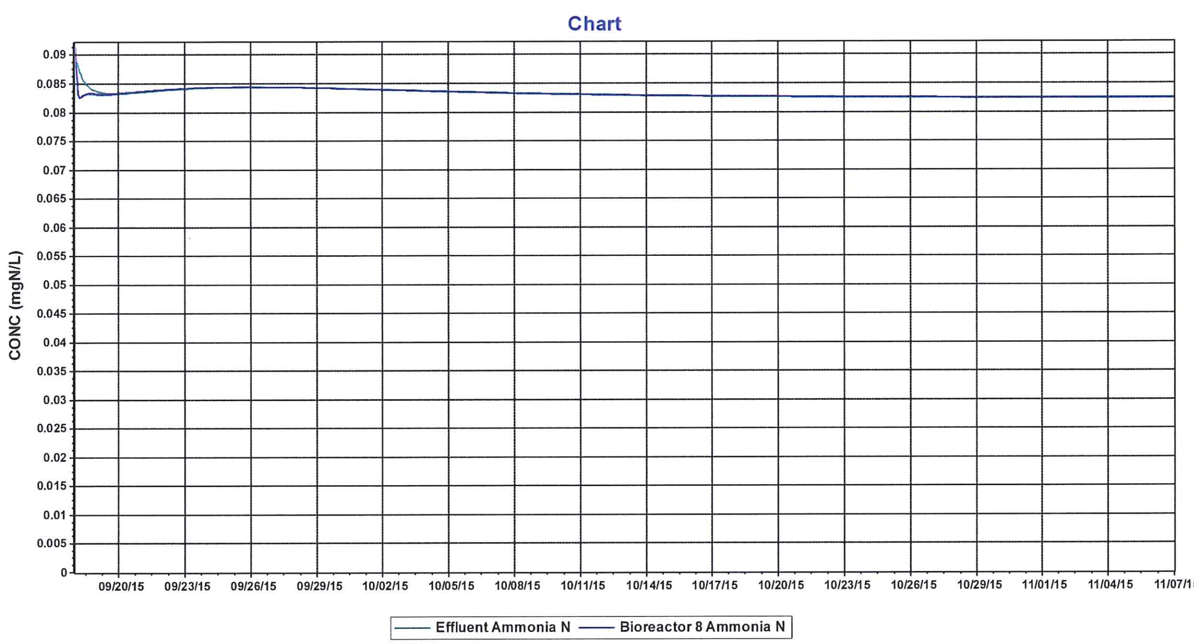


Global Parameters

Common

Name	Default	Value	
Hydrolysis rate [1/d]	2.1000	2.1000	1.0290
Hydrolysis half sat. [-]	0.0600	0.0600	1.0000
Anoxic hydrolysis factor [-]	0.2800	0.2800	1.0000
Anaerobic hydrolysis factor (AS) [-]	0.0400	0.0400	1.0000
Anaerobic hydrolysis factor (AD) [-]	0.5000	0.5000	1.0000
Adsorption rate of colloids [L/(mgCOD d)]	0.1500	0.1500	1.0290
Ammonification rate [L/(mgCOD d)]	0.0800	0.0400	1.0290
Assimilative nitrate/nitrite reduction rate [1/d]	0.5000	0.5000	1.0000
Endogenous products decay rate [1/d]	0	0	1.0000

AOB

Name	Default	Value	
Max. spec. growth rate [1/d]	0.9000	0.9000	1.0720
Substrate (NH4) half sat. [mgN/L]	0.7000	0.7000	1.0000
Byproduct NH4 logistic slope [-]	50.0000	50.0000	1.0000
Byproduct NH4 inflection point [mgN/L]	1.4000	1.4000	1.0000
AOB denite DO half sat. [mg/L]	0.1000	0.1000	1.0000
AOB denite HNO2 half sat. [mgN/L]	5.000E-6	5.000E-6	1.0000
Aerobic decay rate [1/d]	0.1700	0.1700	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0800	0.0800	1.0290
KiHNO2 [mmol/L]	0.0050	0.0050	1.0000

NOB

Name	Default	Value	
Max. spec. growth rate [1/d]	0.7000	0.7000	1.0600
Substrate (NO2) half sat. [mgN/L]	0.1000	0.1000	1.0000
Aerobic decay rate [1/d]	0.1700	0.1700	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0800	0.0800	1.0290
KiNH3 [mmol/L]	0.0750	0.0750	1.0000

AAO

Name	Default	Value	
Max. spec. growth rate [1/d]	0.2000	0.2000	1.1000
Substrate (NH4) half sat. [mgN/L]	2.0000	2.0000	1.0000
Substrate (NO2) half sat. [mgN/L]	1.0000	1.0000	1.0000
Aerobic decay rate [1/d]	0.0190	0.0190	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0095	0.0095	1.0290
Ki Nitrite [mgN/L]	1000.0000	1000.0000	1.0000
Nitrite sensitivity constant [L / (d mgN)]	0.0160	0.0160	1.0000

OHO

Name	Default	Value	
Max. spec. growth rate [1/d]	3.2000	3.2000	1.0290
Substrate half sat. [mgCOD/L]	5.0000	5.0000	1.0000
Anoxic growth factor [-]	0.5000	0.5000	1.0000
Denite N2 producers (NO3 or NO2) [-]	0.5000	0.5000	1.0000
Aerobic decay rate [1/d]	0.6200	0.6200	1.0290
Anoxic decay rate [1/d]	0.2330	0.2330	1.0290
Anaerobic decay rate [1/d]	0.1310	0.1310	1.0290

Fermentation rate [1/d]	1.6000	1.6000	1.0290
Fermentation half sat. [mgCOD/L]	5.0000	5.0000	1.0000
Fermentation growth factor (AS) [-]	0.2500	0.2500	1.0000
Free nitrous acid inhibition [mol/L]	1.000E-7	1.000E-7	1.0000

Methylotrophs

Name	Default	Value	
Max. spec. growth rate [1/d]	1.3000	1.3000	1.0720
Methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
Denite N2 producers (NO3 or NO2) [-]	0.5000	0.5000	1.0000
Aerobic decay rate [1/d]	0.0400	0.0400	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0300	0.0300	1.0000
Free nitrous acid inhibition [mmol/L]	1.000E-7	1.000E-7	1.0000

PAO

Name	Default	Value	
Max. spec. growth rate [1/d]	0.9500	0.9500	1.0000
Max. spec. growth rate, P-limited [1/d]	0.4200	0.4200	1.0000
Substrate half sat. [mgCOD(PHB)/mgCOD(Zbp)]	0.1000	0.1000	1.0000
Substrate half sat., P-limited [mgCOD(PHB)/mgCOD(Zbp)]	0.0500	0.0500	1.0000
Magnesium half sat. [mgMg/L]	0.1000	0.1000	1.0000
Cation half sat. [mmol/L]	0.1000	0.1000	1.0000
Calcium half sat. [mgCa/L]	0.1000	0.1000	1.0000
Aerobic/anoxic decay rate [1/d]	0.1000	0.1000	1.0000
Aerobic/anoxic maintenance rate [1/d]	0	0	1.0000
Anaerobic decay rate [1/d]	0.0400	0.0400	1.0000
Anaerobic maintenance rate [1/d]	0	0	1.0000
Sequestration rate [1/d]	4.5000	4.5000	1.0000
Anoxic growth factor [-]	0.3300	0.3300	1.0000

Acetogens

Name	Default	Value	
Max. spec. growth rate [1/d]	0.2500	0.2500	1.0290
Substrate half sat. [mgCOD/L]	10.0000	10.0000	1.0000
Acetate inhibition [mgCOD/L]	10000.0000	10000.0000	1.0000
Anaerobic decay rate [1/d]	0.0500	0.0500	1.0290
Aerobic/anoxic decay rate [1/d]	0.5200	0.5200	1.0290

Methanogens

Name	Default	Value	
Acetoclastic max. spec. growth rate [1/d]	0.3000	0.3000	1.0290
H2-utilizing max. spec. growth rate [1/d]	1.4000	1.4000	1.0290
Acetoclastic substrate half sat. [mgCOD/L]	100.0000	100.0000	1.0000
Acetoclastic methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
H2-utilizing CO2 half sat. [mmol/L]	0.1000	0.1000	1.0000
H2-utilizing substrate half sat. [mgCOD/L]	1.0000	0.1000	1.0000
H2-utilizing methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
Acetoclastic propionic inhibition [mgCOD/L]	10000.0000	10000.0000	1.0000
Acetoclastic anaerobic decay rate [1/d]	0.1300	0.1300	1.0290
Acetoclastic aerobic/anoxic decay rate [1/d]	0.6000	0.6000	1.0290
H2-utilizing anaerobic decay rate [1/d]	0.1300	0.1300	1.0290
H2-utilizing aerobic/anoxic decay rate [1/d]	2.8000	2.8000	1.0290

pH

Name	Default	Value

OHO low pH limit [-]	4.0000	4.0000
OHO high pH limit [-]	10.0000	10.0000
Methylotrophs low pH limit [-]	4.0000	4.0000
Methylotrophs high pH limit [-]	10.0000	10.0000
Autotrophs low pH limit [-]	5.5000	5.5000
Autotrophs high pH limit [-]	9.5000	9.5000
PAO low pH limit [-]	4.0000	4.0000
PAO high pH limit [-]	10.0000	10.0000
OHO low pH limit (anaerobic) [-]	5.5000	5.5000
OHO high pH limit (anaerobic) [-]	8.5000	8.5000
Propionic acetogens low pH limit [-]	4.0000	4.0000
Propionic acetogens high pH limit [-]	10.0000	10.0000
Acetoclastic methanogens low pH limit [-]	5.0000	5.0000
Acetoclastic methanogens high pH limit [-]	9.0000	9.0000
H2-utilizing methanogens low pH limit [-]	5.0000	5.0000
H2-utilizing methanogens high pH limit [-]	9.0000	9.0000

Switches

Name	Default	Value
OHO DO half sat. [mgO2/L]	0.0500	0.0500
PAO DO half sat. [mgO2/L]	0.0500	0.0500
Anoxic/anaerobic NOx half sat. [mgN/L]	0.1500	0.1500
AOB DO half sat. [mgO2/L]	0.2500	0.2500
NOB DO half sat. [mgO2/L]	0.5000	0.5000
AAO DO half sat. [mgO2/L]	0.0100	0.0100
Anoxic NO3(->NO2) half sat. [mgN/L]	0.1000	0.1000
Anoxic NO3(->N2) half sat. [mgN/L]	0.0500	0.0500
Anoxic NO2(->N2) half sat. (mgN/L)	0.0100	0.0100
NH3 nutrient half sat. [mgN/L]	0.0050	0.0050
PolyP half sat. [mgP/mgCOD]	0.0100	0.0100
VFA sequestration half sat. [mgCOD/L]	5.0000	5.0000
P uptake half sat. [mgP/L]	0.1500	0.1500

P nutrient half sat. [mgP/L]	0.0010	0.0010
Autotroph CO2 half sat. [mmol/L]	0.1000	0.1000
H2 low/high half sat. [mgCOD/L]	1.0000	1.0000
Propionic acetogens H2 inhibition [mgCOD/L]	5.0000	5.0000
Synthesis anion/cation half sat. [meq/L]	0.0100	0.0100

Common

Name	Default	Value
Biomass volatile fraction (VSS/TSS)	0.9200	0.9200
Endogenous residue volatile fraction (VSS/TSS)	0.9200	0.9200
N in endogenous residue [mgN/mgCOD]	0.0700	0.0700
P in endogenous residue [mgP/mgCOD]	0.0220	0.0220
Endogenous residue COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Particulate substrate COD:VSS ratio [mgCOD/mgVSS]	1.6000	1.6000
Particulate inert COD:VSS ratio [mgCOD/mgVSS]	1.6000	1.6000
Molecular weight of other anions [mg/mmol]	35.5000	35.5000
Molecular weight of other cations [mg/mmol]	39.1000	39.1000

AOB

Name	Default	Value
Yield [mgCOD/mgN]	0.1500	0.1500
AOB denite NO2 fraction as TEA [-]	0.5000	0.5000
Byproduct NH4 fraction to N2O [-]	0.0025	0.0025
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

NOB

Name	Default	Value
Yield [mgCOD/mgN]	0.0900	0.0900
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

AAO

Name	Default	Value
Yield [mgCOD/mgN]	0.1140	0.1140
Nitrate production [mgN/mgBiomassCOD]	2.2800	2.2800
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

OHO

Name	Default	Value
Yield (aerobic) [-]	0.6660	0.6660
Yield (fermentation, low H2) [-]	0.1000	0.1000
Yield (fermentation, high H2) [-]	0.1000	0.1000
H2 yield (fermentation low H2) [-]	0.3500	0.3500
H2 yield (fermentation high H2) [-]	0	0
Propionate yield (fermentation, low H2) [-]	0	0
Propionate yield (fermentation, high H2) [-]	0.7000	0.7000
CO2 yield (fermentation, low H2) [-]	0.7000	0.7000

CO2 yield (fermentation, high H2) [-]	0	0
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Endogenous fraction - aerobic [-]	0.0800	0.0800
Endogenous fraction - anoxic [-]	0.1030	0.1030
Endogenous fraction - anaerobic [-]	0.1840	0.1840
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Yield (anoxic) [-]	0.5400	0.5400
Yield propionic (aerobic) [-]	0.6400	0.6400
Yield propionic (anoxic) [-]	0.4600	0.4600
Yield acetic (aerobic) [-]	0.6000	0.6000
Yield acetic (anoxic) [-]	0.4300	0.4300
Yield methanol (aerobic) [-]	0.5000	0.5000
Adsorp. max. [-]	1.0000	1.0000
Max fraction to N2O at high FNA over nitrate [-]	0.0500	0.0500
Max fraction to N2O at high FNA over nitrite [-]	0.1000	0.1000

Methylotrophs

Name	Default	Value
Yield (anoxic) [-]	0.4000	0.4000
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Max fraction to N2O at high FNA over nitrate [-]	0.1000	0.1000
Max fraction to N2O at high FNA over nitrite [-]	0.1500	0.1500

PAO

Name	Default	Value

Yield (aerobic) [-]	0.6390	0.6390
Yield (anoxic) [-]	0.5200	0.5200
Aerobic P/PHA uptake [mgP/mgCOD]	0.9300	0.9300
Anoxic P/PHA uptake [mgP/mgCOD]	0.3500	0.3500
Yield of PHA on sequestration [-]	0.8890	0.8890
N in biomass [mgN/mgCOD]	0.0700	0.0700
N in sol. inert [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous part. [-]	0.2500	0.2500
Inert fraction of endogenous sol. [-]	0.2000	0.2000
P/Ac release ratio [mgP/mgCOD]	0.5100	0.5100
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Yield of low PP [-]	0.9400	0.9400
Mg to P mole ratio in polyphosphate [mmolMg/mmolP]	0.3000	0.3000
Cation to P mole ratio in polyphosphate [meq/mmolP]	0.1500	0.1500
Ca to P mole ratio in polyphosphate [mmolCa/mmolP]	0.0500	0.0500
Cation to P mole ratio in organic phosphate [meq/mmolP]	0.0100	0.0100

Acetogens

Name	Default	Value
Yield [-]	0.1000	0.1000
H2 yield [-]	0.4000	0.4000
CO2 yield [-]	1.0000	1.0000
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Methanogens

Name	Default	Value
Acetoclastic yield [-]	0.1000	0.1000
Methanol acetoclastic yield [-]	0.1000	0.1000
H2-utilizing yield [-]	0.1000	0.1000
Methanol H2-utilizing yield [-]	0.1000	0.1000
N in acetoclastic biomass [mgN/mgCOD]	0.0700	0.0700
N in H2-utilizing biomass [mgN/mgCOD]	0.0700	0.0700
P in acetoclastic biomass [mgP/mgCOD]	0.0220	0.0220
P in H2-utilizing biomass [mgP/mgCOD]	0.0220	0.0220
Acetoclastic fraction to endog. residue [-]	0.0800	0.0800
H2-utilizing fraction to endog. residue [-]	0.0800	0.0800
Acetoclastic COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
H2-utilizing COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

General

Name	Default	Value
Tank head loss per metre of length (from flow) [m/m]	0.0025	0.0025

Heating fuel/Chemical Costs

Name	Default	Value
Methanol [$/gal]	1.6656	1.6656
Ferric [$/gal]	0.3785	0.3785
Aluminium [$/gal]	0.3028	0.3028
Natural gas [$/MMBTU]	3.1652	3.1652
Heating oil [$/gal]	1.8927	1.8927
Diesel [$/gal]	2.6498	2.6498

Custom fuel [$/gal]	3.7854	3.7854
Biogas sale price [$/MMBTU]	2.1101	2.1101

Anaerobic digester

Name	Default	Value
Bubble rise velocity (anaerobic digester) [cm/s]	23.9000	23.9000
Bubble Sauter mean diameter (anaerobic digester) [cm]	0.3500	0.3500
Anaerobic digester gas hold-up factor []	1.0000	1.0000

Combined Heat and Power (CHP) engine

Name	Default	Value
Methane heat of combustion [kJ/mole]	800.0000	800.0000
Hydrogen heat of combustion [kJ/mole]	240.0000	240.0000
CHP engine heat price [$/kWh]	0	0
CHP engine power price [$/kWh]	0.1500	0.1500

Calorific values of heating fuels

Name	Default	Value
Calorific value of natural gas [BTU/lb]	20636	20636
Calorific value of heating fuel oil [BTU/lb]	18057	18057
Calorific value of diesel [BTU/lb]	19776	19776
Calorific value of custom fuel [BTU/lb]	13758	13758

Density of liquid heating fuels

Name	Default	Value
Density of heating fuel oil [lb/ft3]	56	56
Density of diesel [lb/ft3]	55	55
Density of custom fuel [lb/ft3]	49	49

Mass transfer

Name	Default	Value	
Kl for H2 [m/d]	17.0000	17.0000	1.0240
Kl for CO2 [m/d]	10.0000	10.0000	1.0240
Kl for NH3 [m/d]	1.0000	1.0000	1.0240
Kl for CH4 [m/d]	8.0000	8.0000	1.0240
Kl for N2 [m/d]	15.0000	15.0000	1.0240
Kl for N2O [m/d]	8.0000	8.0000	1.0240
Kl for O2 [m/d]	13.0000	13.0000	1.0240

Henry's law constants

Name	Default	Value	
CO2 [M/atm]	3.4000E-2	3.4000E-2	2400.0000
O2 [M/atm]	1.3000E-3	1.3000E-3	1500.0000
N2 [M/atm]	6.5000E-4	6.5000E-4	1300.0000
N2O [M/atm]	2.5000E-2	2.5000E-2	2600.0000
NH3 [M/atm]	5.8000E+1	5.8000E+1	4100.0000
CH4 [M/atm]	1.4000E-3	1.4000E-3	1600.0000
H2 [M/atm]	7.8000E-4	7.8000E-4	500.0000

Properties constants

Name	Default	Value
K in Viscosity = K e ^(Ea/RT) [Pa s]	6.849E-7	6.849E-7
Ea in Viscosity = K e ^(Ea/RT) [j/mol]	1.780E+4	1.780E+4
Y in ML Viscosity = H2O viscosity * (1+A*MLSS^Y) [-]	1.0000	1.0000
A in ML Viscosity = H2O viscosity * (1+A*MLSS^Y) [m3/g]	1.000E-7	1.000E-7
A in ML Density = H2O density + A*MLSS [(kg/m3)/(g/m3)]	3.248E-4	3.248E-4
A in Antoine equn. [T in K, P in Bar {NIST}]	5.2039	5.2039
B in Antoine equn. [T in K, P in Bar {NIST}]	1733.9260	1733.9260
C in Antoine equn. [T in K, P in Bar {NIST}]	-39.5	-39.5

Chemical precipitation rates

Name	Default	Value	
Struvite precipitation rate [1/d]	3.000E+10	3.000E+10	1.0240
Struvite redissolution rate [1/d]	3.000E+11	3.000E+11	1.0240
Struvite half sat. [mgTSS/L]	1.0000	1.0000	1.0000
HDP precipitation rate [L/(molP d)]	1.000E+8	1.000E+8	1.0000
HDP redissolution rate [L/(mol P d)]	1.000E+8	1.000E+8	1.0000
HAP precipitation rate [molHDP/(L d)]	5.000E-4	5.000E-4	1.0000

Chemical precipitation constants

Name	Default	Value
Struvite solubility constant [mol/L]	6.918E-14	6.918E-14
HDP solubility product [mol/L]	2.750E-22	2.750E-22
HDP half sat. [mgTSS/L]	1.0000	1.0000
Equilibrium soluble PO4 with Al dosing at pH 7 [mgP/L]	0.0100	0.0100
Al to P ratio [molAl/molP]	0.8000	0.8000

Al(OH)3 solubility product [mol/L]	1.259E+9	1.259E+9
AlHPO4+ dissociation constant [mol/L]	7.943E-13	7.943E-13
Equilibrium soluble PO4 with Fe dosing at pH 7 [mgP/L]	0.0100	0.0100
Fe to P ratio [molFe/molP]	1.6000	1.6000
Fe(OH)3 solubility product [mol/L]	0.0500	0.0500
FeH2PO4++ dissociation constant [mol/L]	5.012E-22	5.012E-22

Pipe and pump parameters

Name	Default	Value
Static head [ft]	0.8202	0.8202
Pipe length (headloss calc.s) [ft]	164.0420	164.0420
Pipe inside diameter [in]	19.68504	19.68504
K(fittings) - Total minor losses K	5.0000	5.0000
Pipe roughness [in]	0.00787	0.00787
'A' in overall pump efficiency = A + B*Q + C*(Q^2)[-]	0.8500	0.8500
'B' in overall pump efficiency = A + B*Q + C*(Q^2)[[-]/(mgd)]	0	0
'C' in overall pump efficiency = A + B*Q + C*(Q^2)[[-]/(mgd)^2]	0	0

Fittings and loss coefficients ('K' values)

Name	Default	Value
Pipe entrance (bellmouth)	0.0500	1.0000
90° bend	0.7500	5.0000
45° bend	0.3000	2.0000
Butterfly value (open)	0.3000	1.0000
Non-return value	1.0000	0
Outlet (bellmouth)	0.2000	1.0000

Aeration

Name	Default	Value
Surface pressure [kPa]	101.3250	101.3250
Fractional effective saturation depth (Fed) [-]	0.3250	0.3250
Supply gas CO2 content [vol. %]	0.0350	0.0350
Supply gas O2 [vol. %]	20.9500	20.9500
Off-gas CO2 [vol. %]	2.0000	2.0000
Off-gas O2 [vol. %]	18.8000	18.8000
Off-gas H2 [vol. %]	0	0
Off-gas NH3 [vol. %]	0	0
Off-gas CH4 [vol. %]	0	0
Off-gas N2O [vol. %]	0	0
Surface turbulence factor [-]	2.0000	2.0000
Set point controller gain []	1.0000	1.0000

Blower

Name	Default	Value
Intake filter pressure drop [psi]	0.5076	0.5076
Pressure drop through distribution system (piping/valves) [psi]	0.4351	0.4351
Adiabatic/polytropic compression exponent (1.4 for adiabatic)	1.4000	1.4000
'A' in blower efficiency = A + B*Qa + C*(Qa^2)[-]	0.7500	0.7500
'B' in blower efficiency = A + B*Qa + C*(Qa^2)[[-]/(ft3/min (20C, 1 atm))]	0	0
'C' in blower efficiency = A + B*Qa + C*(Qa^2)[[-]/(ft3/min (20C, 1 atm))^2]	0	0

Diffuser

Name	Default	Value
k1 in C = k1(PC)^0.25 + k2	1.2400	1.2400

k2 in C = k1(PC)^0.25 + k2	0.8960	0.8960
Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)]	0.8880	0.8880
Area of one diffuser [ft2]	0.4413	0.4413
Diffuser mounting height [ft]	0.8202	0.8202
Min. air flow rate per diffuser ft3/min (20C, 1 atm)	0.2943	0.2943
Max. air flow rate per diffuser ft3/min (20C, 1 atm)	5.8858	5.8858
'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2 [psi]	0.4351	0.4351
'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2[psi/(ft3/min (20C, 1 atm))]	0	0
'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2[psi/(ft3/min (20C, 1 atm))^2]	0	0

Surface aerators

Name	Default	Value
Surface aerator Std. oxygen transfer rate [lb O /(hp hr)]	2.46697	2.46697
Maximum power per rotor [hp]	26.80965	26.80965

Modified Vesilind

Name	Default	Value
Maximum Vesilind settling velocity (Vo) [ft/min]	0.387	0.387
Vesilind hindered zone settling parameter (K) [L/g]	0.370	0.370
Clarification switching function [mg/L]	100.000	100.000
Specified TSS conc.for height calc. [mg/L]	2500.000	2500.000
Maximum compactability constant [mg/L]	15000.000	15000.000

Double exponential

Name	Default	Value
Maximum Vesilind settling velocity (Vo) [ft/min]	0.934	0.934

Maximum (practical) settling velocity (Vo') [ft/min]	0.615	0.615
Hindered zone settling parameter (Kh) [L/g]	0.400	0.400
Flocculent zone settling parameter (Kf) [L/g]	2.500	2.500
Maximum non-settleable TSS [mg/L]	20.0000	20.0000
Non-settleable fraction [-]	0.0010	0.0010
Specified TSS conc. for height calc. [mg/L]	2500.0000	2500.0000

Emission factors

Name	Default	Value
Carbon dioxide equivalence of nitrous oxide	296.0000	296.0000
Carbon dioxide equivalence of methane	23.0000	23.0000

Biofilm general

Name	Default	Value	
Attachment rate [g / (m2 d)]	80.0000	80.0000	1.0000
Attachment TSS half sat. [mg/L]	100.0000	100.0000	1.0000
Detachment rate [g/(m3 d)]	8.000E+4	8.000E+4	1.0000
Solids movement factor []	10.0000	10.0000	1.0000
Diffusion neta []	0.8000	0.8000	1.0000
Thin film limit [mm]	0.5000	0.5000	1.0000
Thick film limit [mm]	3.0000	3.0000	1.0000
Assumed Film thickness for tank volume correction (temp independent) [mm]	0.7500	0.7500	1.0000
Film surface area to media area ratio - Max.[ ]	1.0000	1.0000	1.0000
Minimum biofilm conc. for streamer formation [gTSS/m2]	4.0000	4.0000	1.0000

Maximum biofilm concentrations [mg/L]

Name	Default	Value	
Ordinary heterotrophic organisms (OHO)	5.000E+4	5.000E+4	1.0000
Methylotrophs	5.000E+4	5.000E+4	1.0000
Ammonia oxidizing biomass (AOB)	1.000E+5	1.000E+5	1.0000
Nitrite oxidizing biomass (NOB)	1.000E+5	1.000E+5	1.0000
Anaerobic ammonia oxidizers (AAO)	5.000E+4	5.000E+4	1.0000
Polyphosphate accumulating organisms (PAO)	5.000E+4	5.000E+4	1.0000
Propionic acetogens	5.000E+4	5.000E+4	1.0000
Methanogens - acetoclastic	5.000E+4	5.000E+4	1.0000
Methanogens - hydrogenotrophic	5.000E+4	5.000E+4	1.0000
Endogenous products	3.000E+4	3.000E+4	1.0000
Slowly bio. COD (part.)	5000.0000	5000.0000	1.0000
Slowly bio. COD (colloid.)	4000.0000	4000.0000	1.0000
Part. inert. COD	5000.0000	5000.0000	1.0000
Part. bio. org. N	0	0	1.0000
Part. bio. org. P	0	0	1.0000
Part. inert N	0	0	1.0000
Part. inert P	0	0	1.0000
Stored PHA	5000.0000	5000.0000	1.0000
Releasable stored polyP	1.150E+6	1.150E+6	1.0000
Fixed stored polyP	1.150E+6	1.150E+6	1.0000
Readily bio. COD (complex)	0	0	1.0000
Acetate	0	0	1.0000
Propionate	0	0	1.0000
Methanol	0	0	1.0000
Dissolved H2	0	0	1.0000
Dissolved CH4	0	0	1.0000
Ammonia N	0	0	1.0000
Sol. bio. org. N	0	0	1.0000
Nitrous Oxide N	0	0	1.0000
Nitrite N	0	0	1.0000
Nitrate N	0	0	1.0000
Dissolved N2	0	0	1.0000

PO4-P (Sol. & Me Complexed)	1.000E+10	1.000E+10	1.0000
Sol. inert COD	0	0	1.0000
Sol. inert TKN	0	0	1.0000
ISS Influent	1.300E+6	1.300E+6	1.0000
Struvite	8.500E+5	8.500E+5	1.0000
Hydroxy-dicalcium-phosphate	1.150E+6	1.150E+6	1.0000
Hydroxy-apatite	1.600E+6	1.600E+6	1.0000
Magnesium	0	0	1.0000
Calcium	0	0	1.0000
Metal	1.000E+10	1.000E+10	1.0000
Other Cations (strong bases)	0	0	1.0000
Other Anions (strong acids)	0	0	1.0000
Total CO2	0	0	1.0000
User defined 1	0	0	1.0000
User defined 2	0	0	1.0000
User defined 3	5.000E+4	5.000E+4	1.0000
User defined 4	5.000E+4	5.000E+4	1.0000
Dissolved O2	0	0	1.0000

Effective diffusivities [m2/s]

Name	Default	Value	
Ordinary heterotrophic organisms (OHO)	5.000E-14	5.000E-14	1.0290
Methylotrophs	5.000E-14	5.000E-14	1.0290
Ammonia oxidizing biomass (AOB)	5.000E-14	5.000E-14	1.0290
Nitrite oxidizing biomass (NOB)	5.000E-14	5.000E-14	1.0290
Anaerobic ammonia oxidizers (AAO)	5.000E-14	5.000E-14	1.0290
Polyphosphate accumulating organisms (PAO)	5.000E-14	5.000E-14	1.0290
Propionic acetogens	5.000E-14	5.000E-14	1.0290
Methanogens - acetoclastic	5.000E-14	5.000E-14	1.0290
Methanogens - hydrogenotrophic	5.000E-14	5.000E-14	1.0290
Endogenous products	5.000E-14	5.000E-14	1.0290
Slowly bio. COD (part.)	5.000E-14	5.000E-14	1.0290

Slowly bio. COD (colloid.)	5.000E-10	5.000E-12	1.0290
Part. inert. COD	5.000E-14	5.000E-14	1.0290
Part. bio. org. N	5.000E-14	5.000E-14	1.0290
Part. bio. org. P	5.000E-14	5.000E-14	1.0290
Part. inert N	5.000E-14	5.000E-14	1.0290
Part. inert P	5.000E-14	5.000E-14	1.0290
Stored PHA	5.000E-14	5.000E-14	1.0290
Releasable stored polyP	5.000E-14	5.000E-14	1.0290
Fixed stored polyP	5.000E-14	5.000E-14	1.0290
Readily bio. COD (complex)	6.900E-10	6.900E-10	1.0290
Acetate	1.240E-9	1.240E-9	1.0290
Propionate	8.300E-10	8.300E-10	1.0290
Methanol	1.600E-9	1.600E-9	1.0290
Dissolved H2	5.850E-9	5.850E-9	1.0290
Dissolved CH4	1.963E-9	1.963E-9	1.0290
Ammonia N	2.000E-9	2.000E-9	1.0290
Sol. bio. org. N	1.370E-9	1.370E-9	1.0290
Nitrous Oxide N	1.607E-9	1.607E-9	1.0290
Nitrite N	2.980E-9	2.980E-9	1.0290
Nitrate N	2.980E-9	2.980E-9	1.0290
Dissolved N2	1.900E-9	1.900E-9	1.0290
PO4-P (Sol. & Me Complexed)	2.000E-9	2.000E-9	1.0290
Sol. inert COD	6.900E-10	6.900E-10	1.0290
Sol. inert TKN	6.850E-10	6.850E-10	1.0290
ISS Influent	5.000E-14	5.000E-14	1.0290
Struvite	5.000E-14	5.000E-14	1.0290
Hydroxy-dicalcium-phosphate	5.000E-14	5.000E-14	1.0290
Hydroxy-apatite	5.000E-14	5.000E-14	1.0290
Magnesium	7.200E-10	7.200E-10	1.0290
Calcium	7.200E-10	7.200E-10	1.0290
Metal	4.800E-10	4.800E-10	1.0290
Other Cations (strong bases)	1.440E-9	1.440E-9	1.0290
Other Anions (strong acids)	1.440E-9	1.440E-9	1.0290
Total CO2	1.960E-9	1.960E-9	1.0290
User defined 1	6.900E-10	6.900E-10	1.0290

User defined 2	6.900E-10	6.900E-10	1.0290
User defined 3	5.000E-14	5.000E-14	1.0290
User defined 4	5.000E-14	5.000E-14	1.0290
Dissolved O2	2.500E-9	2.500E-9	1.0290

EPS Strength coefficients [ ]

Name	Default	Value	
Ordinary heterotrophic organisms (OHO)	1.0000	1.0000	1.0000
Methylotrophs	1.0000	1.0000	1.0000
Ammonia oxidizing biomass (AOB)	5.0000	5.0000	1.0000
Nitrite oxidizing biomass (NOB)	25.0000	25.0000	1.0000
Anaerobic ammonia oxidizers (AAO)	10.0000	10.0000	1.0000
Polyphosphate accumulating organisms (PAO)	1.0000	1.0000	1.0000
Propionic acetogens	1.0000	1.0000	1.0000
Methanogens - acetoclastic	1.0000	1.0000	1.0000
Methanogens - hydrogenotrophic	1.0000	1.0000	1.0000
Endogenous products	1.0000	1.0000	1.0000
Slowly bio. COD (part.)	1.0000	1.0000	1.0000
Slowly bio. COD (colloid.)	1.0000	1.0000	1.0000
Part. inert. COD	1.0000	1.0000	1.0000
Part. bio. org. N	1.0000	1.0000	1.0000
Part. bio. org. P	1.0000	1.0000	1.0000
Part. inert N	1.0000	1.0000	1.0000
Part. inert P	1.0000	1.0000	1.0000
Stored PHA	1.0000	1.0000	1.0000
Releasable stored polyP	1.0000	1.0000	1.0000
Fixed stored polyP	1.0000	1.0000	1.0000
Readily bio. COD (complex)	0	0	1.0000
Acetate	0	0	1.0000
Propionate	0	0	1.0000
Methanol	0	0	1.0000
Dissolved H2	0	0	1.0000

Dissolved CH4	0	0	1.0000
Ammonia N	0	0	1.0000
Sol. bio. org. N	0	0	1.0000
Nitrous Oxide N	0	0	1.0000
Nitrite N	0	0	1.0000
Nitrate N	0	0	1.0000
Dissolved N2	0	0	1.0000
PO4-P (Sol. & Me Complexed)	1.0000	1.0000	1.0000
Sol. inert COD	0	0	1.0000
Sol. inert TKN	0	0	1.0000
ISS Influent	0.3300	0.3300	1.0000
Struvite	1.0000	1.0000	1.0000
Hydroxy-dicalcium-phosphate	1.0000	1.0000	1.0000
Hydroxy-apatite	1.0000	1.0000	1.0000
Magnesium	0	0	1.0000
Calcium	0	0	1.0000
Metal	1.0000	1.0000	1.0000
Other Cations (strong bases)	0	0	1.0000
Other Anions (strong acids)	0	0	1.0000
Total CO2	0	0	1.0000
User defined 1	0	0	1.0000
User defined 2	0	0	1.0000
User defined 3	1.0000	1.0000	1.0000
User defined 4	1.0000	1.0000	1.0000
Dissolved O2	0	0	1.0000

APPENDIX B

Process Aeration Calculations

Inland Bays RWF - PHASE 2 Expansion
PROCESS CALCULATIONS (N-removal and Process Air Requirements)

	Units	*Average at Startup*	*Phase 1*	*IB Phase 2 Annual Average*	*IB Phase 2 Max Month, Summer*	*Comments*
Process Criteria						
Influent Flow	MGD	**0.90**	**2.20**	**3.30**	**4.30**	Secondary Influent (incl plant recycle)
Influent BOD5	mg/L	**190**	**190**	**247**	**247**	
	lb/day	1,426	3,486	6,798	8,858	
Influent TSS	mg/L	**220**	**220**	**286**	**286**	
	lb/day	1,651	4,037	7,871	10,257	
Influent TKN	mg/L	**40**	**40**	**52**	**52**	
	lb/day	300	734	1,431	1,865	
Influent NH3-N	mg/L	**25**	**25**	**39**	**39**	
	lb/day	188	459	1,073	1,399	
Influent Alkalinity	mg/L	**250**	--	--	--	Assumed. No Plant Data
Design Effluent Objectives:						
Effluent BOD5	mg/L	**10**	**10**	**10**	**10**	
	lb/day	75	183	275	359	
Effluent TSS	mg/L	**10**	**10**	**10**	**10**	
	lb/day	75	183	275	359	
Effluent TKN-N	mg/L	**4**	**4**	**4**	**4**	Not a permit parameter; used for aeration calculations
	lb/day	30.0	73.4	110.1	143.4	
Effluent Total Nitrogen	mg/L	**10.0**	**10.0**	**10.0**	**10.0**	Design Goal: 10 mg/L
	lb/day	75.1	183.5	275.2	358.6	
Lagoon Dimensions:						
Length	ft	**195**	195	195	195	
Width	ft	**100**	100	100	100	Phase 1 - 2 Lagoons, Phase 2 - 4 Lagoons
Side Water Depth	ft	**12.0**	12.00	12.00	12.00	
Volume	ft^3	468,000	468,000	936,000	936,000	
	gal	3,500,640	3,500,640	7,001,280	7,001,280	
Biological Nutrient Removal Calculations						
Influent Nitrogen						
TKN	lb/day	300.2	733.9	1,431.1	1,864.8	
NH3-N	lb/day	187.7	458.7	1,073.4	1,398.6	
Organic - N	lb/day	112.6	275.2	357.8	466.2	
NOx-N	lb/day	16.0	24.0	24.0	24.0	
Total Nitrogen (TN)	lb/day	316.2	757.9	1,455.1	1,888.8	
TKN Associated with waste sludge	lb/day	140.0	154	308	350	Assume WS contains 7% N by weight
Effluent Nitrogen without Denitrification						
TKN	lb/day	30.0	73.4	110.1	143.4	

Inland Bays RWF - PHASE 2 Expansion
PROCESS CALCULATIONS (N-removal and Process Air Requirements)

	Units	*Average at Startup*	*Phase 1*	*IB Phase 2 Annual Average*	*IB Phase 2 Max Month, Summer*	*Comments*
NH3-N	lb/day	30.0	73.4	110.1	143.4	Assumes 1 mg/L effluent NH3 concentration
Organic - N	lb/day	112.6	275.2	357.8	466.2	
NOx-N	lb/day	146.2	530.5	1,037.1	1,395.4	
Total Nitrogen (TN)	lb/day	176.2	603.9	1,147.1	1,538.8	
Effluent TN Objective	mg/L	10.0	10.0	10.0	10.0	
	lb/day	75.1	183.5	275.2	358.6	
Denitrification Required	lb/day	101.2	420.4	871.9	1,180.2	
Oxygen and Blower Calculations						
Input Parameters:						
Influent BOD5 Load	lb/day	1,426	3,486	6,798	8,858	
Effluent BOD5 Load	lb/day	75	183	275	359	
Influent TKN-N Load	lb/day	300	734	1,431	1,865	
Effluent TKN-N Load	lb/day	30	73	110	143	
Oxygen Requirement for BOD Removal	lb O2/lb BOD5 Removed	**1.50**	**1.50**	**1.50**	**1.50**	MDE/Ten States Stds: 1.1 lb O_2/lb BOD_5 removed (1.5 for extended aeration)
Oxygen Requirement for Nitrification	lb O2/lb NH3-N oxidized	**4.6**	**4.6**	**4.6**	**4.6**	
Design Temp. - Minimum	°C	**12**	**12**	**12**	**12**	
Design Temp. - Maximum	°C	**20**	**20**	**20**	**20**	
Wastewater Correction Factor (α)	-	**0.45**	**0.45**	**0.45**	**0.45**	Coarse bubble aeration: 0.7 - 0.8; Fine bubble aeration: 0.4 - 0.5
Salinity Correction Factor (β)	-	**0.95**	**0.95**	**0.95**	**0.95**	
Temperature Correction Factor (Θ)	-	**1.024**	**1.024**	**1.024**	**1.024**	
Barometric Pressure at mean sea level	in Hg	**29.92**	**29.92**	**29.92**	**29.92**	
Site Elevation	ft	**30**	**30**	**30**	**30**	
Barometric Pressure at site	in Hg	**29.81**	**29.81**	**29.81**	**29.81**	
Elevation Correction Factor (Ω)	-	1.00	1.00	1.00	1.00	Ω = Barometric Pressure at site/Barometric Pressure at MSL
D.O. Concentration at Min Temp. (C_s)	mg/L	**10.07**	**10.07**	**10.07**	**10.07**	
D.O. Concentration at Max Temp. (C_s)	mg/L	**9.08**	**9.08**	**9.08**	**9.08**	
Target Minimum D.O. Concentration (C_w)	mg/L	**2.00**	**2.00**	**2.00**	**2.00**	
D.O. Concentration at Standard Temp. ($C_{s,20}$)	mg/L	**9.08**	**9.08**	**9.08**	**9.08**	
D.O. Conc. Increase w/ Diffuser Submergence	mg/ft-submergence	**0.1**	**0.1**	**0.1**	**0.1**	
Diffuser Submergence	ft	**11.0**	**11.0**	**11.0**	**11.0**	Estimate diffusers to be 12" from bottom of basin
Calculations:						

Inland Bays RWF - PHASE 2 Expansion
PROCESS CALCULATIONS (N-removal and Process Air Requirements)

	Units	*Average at Startup*	*Phase 1*	*IB Phase 2 Annual Average*	*IB Phase 2 Max Month, Summer*	*Comments*
Fraction of TKN-N Oxidized to NO3		**0.90**	**0.90**	**0.90**	**0.90**	
Actual Oxygen Required (AOR) without Denitrification Credit	lb/day	3,160	7,725	15,308	19,947	AOR = lb/day BOD5 removed*1.1 + lb/day NH3-N oxidized*4.6 + min residual DO conc (mg/L)
AOR credit from denitrification	lb O_2/lb NO_3^- denit	2.86	2.86	2.86	2.86	
Denitrification Oxygen Credit	lb/day	289	1,201	2,490	3,371	
Actual Oxygen Required (AOR) including Denitrification Credit	lb/day	2,871	6,524	12,818	16,576	
AOR/SOR Ratio (at max temperature)	-	0.378	0.378	0.378	0.378	AOR/SOR = $(\beta C_s \Omega - C_w)/C_{s.20} \times \Theta^{(T-20)} \times \alpha$
AOR/SOR Ratio (at min temperature)	-	0.351	0.351	0.351	0.351	AOR/SOR = $(\beta C_s \Omega - C_w)/C_{s.20} \times \Theta^{(T-20)} \times \alpha$
Standard Oxygen Required (SOR) @ max temperature	lb/day	7,588	17,242	33,874	43,806	
Standard Oxygen Required (SOR) @ min temperature	lb/day	8,171	18,566	36,474	47,169	
Design Standard Oxygen Required (SOR)	lb/day	8,171	18,566	36,474	47,169	
Standard Oxygen Transfer Efficiency (SOTE) at maximum diffuser submergence	%	**22.0**	**22.0**	**22.0**	**22.0**	Estimate. Assume 2 % per ft of diffuser submergence (fine bubble)
Mass of Oxygen Required	lb O2/day	37,139	84,389	165,793	214,406	O2 Mass = SOR/[SOTE at average diffuser submergence]
Air Density (at sea level)	lb/ft^3	0.075	0.075	0.075	0.075	
Oxygen Content of Air	% by weight	23.20	23.20	23.20	23.20	
Volume of Air Required	SCFM	1,482	3,368	6,617	8,557	
Design Factor		1.0	1.0	1.0	1.0	
Design Air Requirement	SCFM	1,482	3,368	6,617	8,557	
Aerated Fraction of Total Volume	%	**63**	**63**	**63**	**63**	Cyclic Aeration
Aerated Reactor Volume		292,500	292,500	585,000	585,000	
Check Mixing Density (Volume Basis) at Design Air Volume Required	SCFM/1000 ft^3	5.1	11.5	11.3	14.6	Minimum mixing requirement for fine pore system is 7.0 SCFM/1000 ft^3 (coarse bubble mixing at 20-30 SCFM/1000 ft^3)
Check Mixing Requirements (Reactor Surface Basis) for Aerated Reactors - ACTIVATED SLUDGE	SCFM	1,219	1,219	1,219	1,219	Activated Sludge MLSS (0.1 scfm/SF)
Maximum Static Head	ft	**11.0**	**11.0**	**11.0**	**11.0**	Diffuser submergence depth
Friction Losses	ft	**1.0**	**1.5**	**2.0**	**2.0**	Assume < approx. 1.0 psig
Discharge Pressure Required	psi	5.7	6.0	6.2	6.2	Includes 10% design factor
Number of blowers	each	**3**	3	5	5	Duty blowers + 1 standby unit

Inland Bays RWF - PHASE 2 Expansion
PROCESS CALCULATIONS (N-removal and Process Air Requirements)

	Units	*Average at Startup*	*Phase 1*	*IB Phase 2 Annual Average*	*IB Phase 2 Max Month, Summer*	*Comments*
Air flow Rate req'd per Blower	SCFM	741	1,684	1,654	2,139	Air flow per each duty blower
Selected Blower Rated Capacity	SCFM	**2,200**	**2,200**	**2,200**	**2,200**	Standard T = 68 F
Inlet Pressure	atm	1	--	--	--	
Supply Pressure	atm	1.39	--	--	--	
Inlet temperature	R	560	--	--	--	Max Temp = 100F
Blower Efficiency	%	0.70	--	--	--	
Electrical Efficiency	%	0.9	--	--	--	
Actual CFM @ Max Inlet Temp	ACFM	2,333	--	--	--	
Blower Power Req'd @ Max inlet T	HP	81.5	--	--	--	
Motor Size Factor		**1.2**				Accounts for Blower Power at Min T
Blower Power, ACFM @ Min inlet T	HP	98				Min Temp = 15F
Motor Size Selection	HP	**125.0**	--	--	--	

APPENDIX C

Spray Discharge Permit No. LTS 5004-90-12

State Permit No. LTS 5004-90-12
DEN Number: 359141-05
Effective Date: July 13, 2012
Amended Date: October 16, 2012
Amended Date: March 14, 2013
Expiration Date: July 12, 2017

Spray Irrigation Permit

Issued by: Ground Water Discharges Section
Division of Water
Department of Natural Resources
and Environmental Control
89 Kings Highway
Dover Delaware 19901
302-739-9948

AUTHORIZATION TO OPERATE AND MAINTAIN

UNDER THE LAWS OF THE

STATE OF DELAWARE

PERMITTEE: Sussex County Council
PO Box 589
Georgetown DE 19947

FACILITY: Inland Bays Regional Wastewater Treatment Facility

1. Pursuant to the provisions of 7 Del. C. §6003, **Sussex County Council** is herein authorized to operate and maintain the facility known as **Inland Bays Regional Wastewater Treatment Facility** located on the north side of County Road 306, between County Road 307 and 303, Sussex County, Delaware (Sussex County Tax Map Parcel Number 2-34-22-14) to collect and treat domestic wastewater from the Long Neck Sanitary Sewer District (LNSSD), the Oak Orchard Sanitary Sewer District (OOSSD), and the Angola Sanitary Sewer District (ANSSD) and to spray irrigate the treated wastewater on spray fields located both north and south of Country Road 306, west of County Road 307, east of County Road 303, and north of County Road 297, Sussex County Delaware.

2. The effluent limitations, monitoring requirements and other permit conditions are set forth in Part I, II and III hereof.

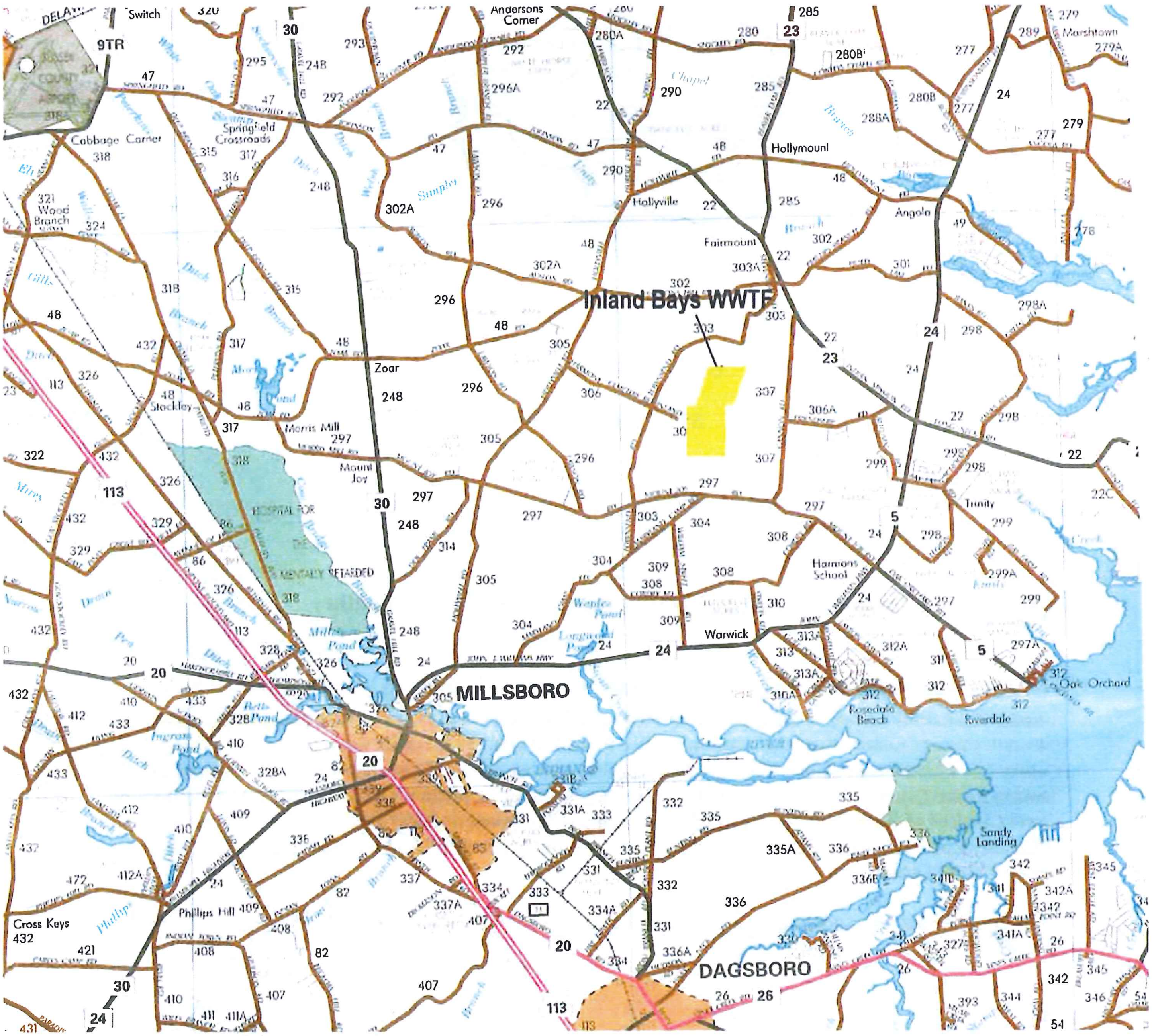
Ronald E. Graeber

Ronald E. Graeber, Program Manager
Ground Water Discharges Section
Division of Water
Department of Natural Resources
and Environmental Control

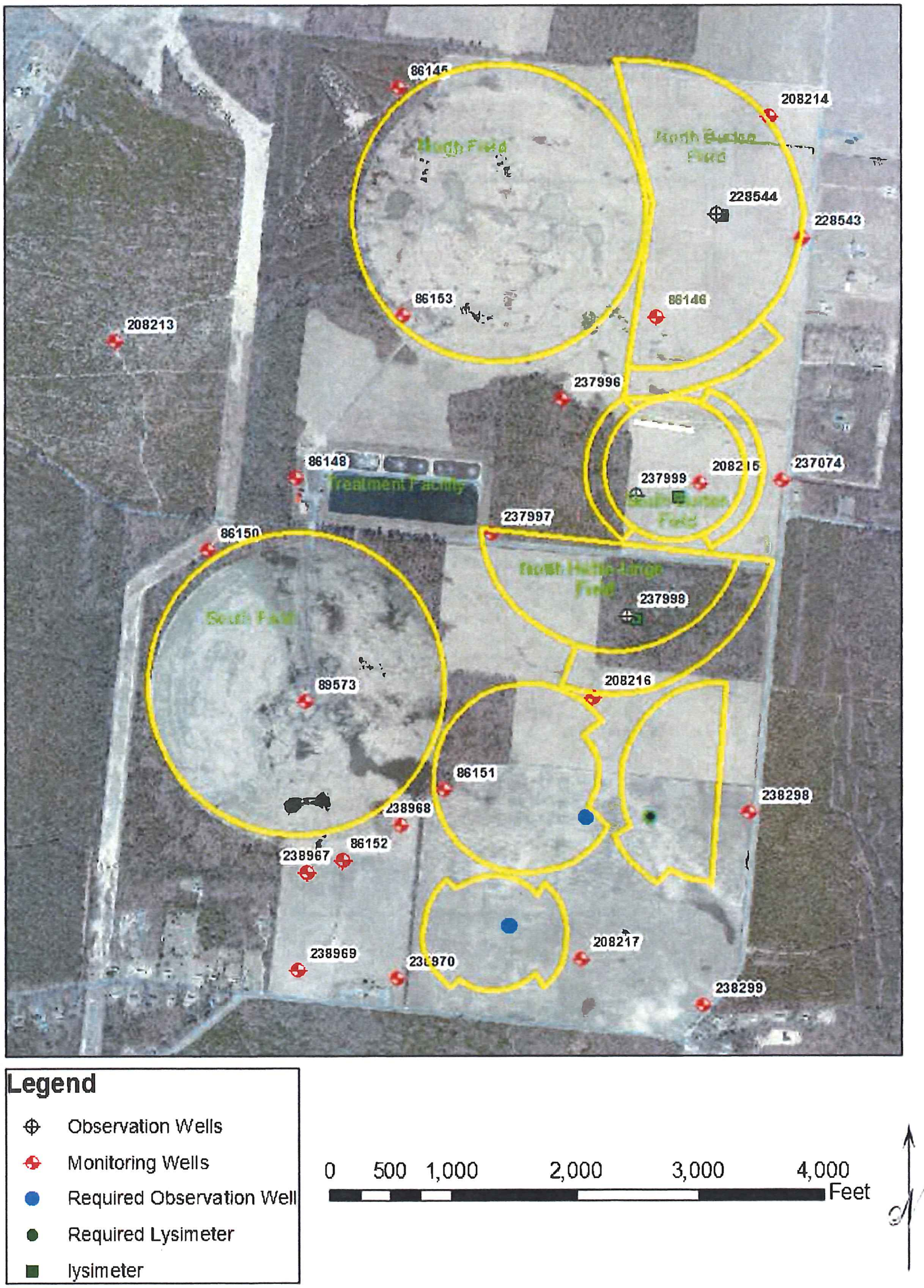
March 14, 2013

Date Signed

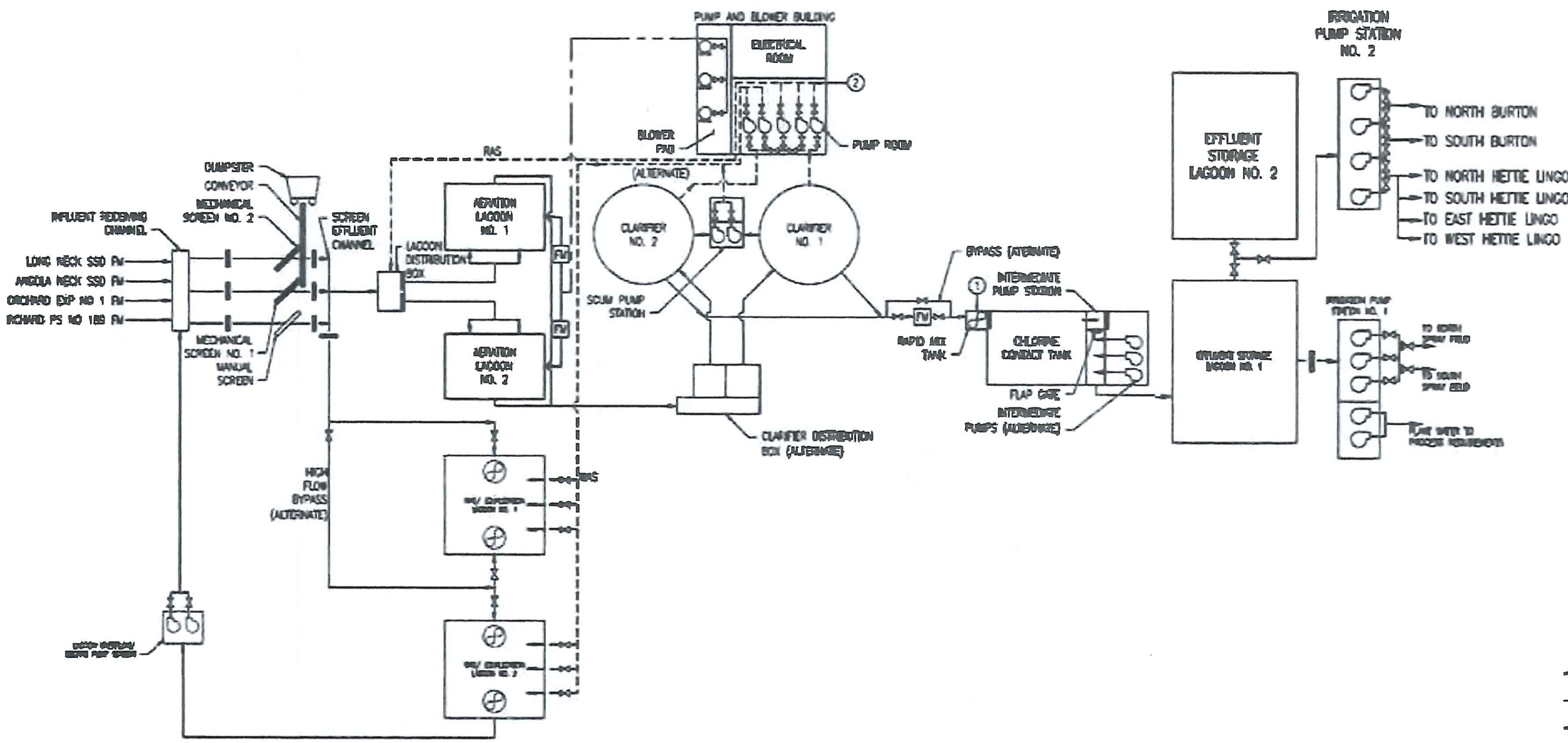
LOCATION MAP



Inland Bays Regional Wastewater Treatment Facility Site Map



PROCESS FLOW DIAGRAM



PHASE 1 PROCESS FLOW SCHEMATIC

NOT TO SCALE

NOTE:

1. NOT ALL VALVES SHOWN FOR CLARITY.
2. REFER TO M00.04 FOR PHASE 1 DESIGN CRITERIA.

KEY

1 SODIUM HYPOCHLORITE (CONTINUO
2 SODIUM HYPOCHLORITE (MAINTENAN

LEGEND

(THICK) NEW
(thin) Existing
MAIN PROCESS FLOW
EXISTING PIPING
SLUDGE/ SIDESTREAM
OTHER FLOW (AIR, CHEMICAL)
ISOLATION VALVE
PUMP
BLOWER
FM FLOW METER
MIXER
MECHANICAL AERATOR/ MIXER
SLIDE GATE

PART I

A. DOCUMENTATION

The slow rate land treatment operation shall be conducted in accordance with the following documents:

1. The State of Delaware, Department of Natural Resources and Environmental Control's Guidance and Regulations Governing the Land Treatment of Wastes, (hereafter called Regulations).
2. The Design Development Report (DDR) submitted by Metcalf and Eddy, dated April 27, 1989; received May 8, 1989.
3. Plans and Technical Specifications submitted by Metcalf and Eddy dated December 27, 1989.
4. A letter dated March 20, 1990 from Robert J. Zimmerman to Mr. Robert Woods approving the DDR as submitted contingent upon several revisions to the final Plans and Specifications.
5. The Operations and Maintenance Manual dated October 1991; revised April 8, 1992.
6. A letter dated September 21, 1994 from D. Preston Lee, Jr. to Ronald E. Graeber transmitting additional information on the proposed wastewater treatment system and revised DDR.
7. October 18, 2005 *Soil Investigations of the Inland Bays Wastewater Treatment Facility Expansion Tracts* prepared by Geo-Sci Consultants, Inc. on behalf of Sussex County Council submitted to the Ground Water Discharges Section under cover letter dated July 18, 2006.
8. November 27, 2006 *Hydrogeologic Report for the Expansion of the Inland Bays Regional Wastewater Facilities* prepared by Whitman, Requardt and Associates, LLP.
9. April 2009 Design Development Report for the Expansion of the Inland Bays Regional Wastewater Facility to include Burton Field prepared for Sussex County by Stearns & Wheler, LLC in association with Whitman, Requardt and Associates, LLP received May 6, 2009.
10. June 4, 2009 Hydro Geological Review performed by DNREC's Ground Water Protection Branch and forwarded to Sussex County via standard and electronic mail on June 9, 2009.
11. June 24, 2009 letter from Sussex County to the Ground Water Discharges Section.
12. September 2009 *Final Inland Bays Regional Wastewater Facility Design Development Report* prepared by Stearns & Wheeler Environmental Engineers & Scientists in associate with Whitman, Requardt and Associates, LLP on behalf of Sussex County Council submitted to the Ground Water Discharges Section on October 2, 2009.
13. November 5, 2009 Plans and Technical Specifications for the Phase 1 project, Contract 09-19 prepared by Whitman, Requardt and Associates, LLP in association with Stearns and Wheler on behalf of Sussex County Council submitted to the Ground Water Discharges Section on November 19, 2009.
14. May 24, 2012 Spray Irrigation Permit Application for renewal and an amendment to included Expansion 1 construction modifications to increase the treatment and disposal capacity of the Facility.
15. June 2012 Operation and Maintenance Plan Volumes 1 thru 6 titled *Sussex County Inland Bays Facility Expansion Number 1.*
16. August 15, 2012 *Application for a Permit to Spray Irrigate Wastewater*
17. October 2012 *Inland Bays Regional Wastewater Facility Phase 2A Expansion:Spray Irrigation Improvements Design Development Report* prepared by GHD Inc. in association with Whitman, Requardt and Associates, LLP on behalf of Sussex County Council submitted to the Ground Water Discharges Section on October 19, 2012.

18. December 2012 Final Plans/Drawings titled *Inland Bays Regional Wastewater Facility Phase 2A Expansion:Spray Irrigation Improvements* prepared by Davis, Bowen and Friedel, Inc. on behalf of Sussex County Council submitted to the Ground Water Discharges Section on December 21, 2012.

19. Emails providing additional calculations and clarification dated:
    a. January 17, 2013 from Heather Sheridan, Sussex County
    b. January 24, 2013 from John Stullken, GHD
    c. March 1, 2013 from Heather Sheridan, Sussex County

20. Any other correspondence, documentation and/or reports related to the **Inland Bays Regional Wastewater Treatment Facility** received and approved by the Ground Water Discharges Section and/or sent by the Ground Water Discharges Section.

B. GENERAL DESCRIPTION OF OPERATION/DISCHARGES

The Inland Bays Wastewater Treatment Facility collects and treats domestic wastewater from the Long Neck Sanitary Sewer District (LNSSD), the Oak Orchard Sanitary Sewer District (OOSSD), and the Angola Sanitary Sewer District (ANSSD).

The Inland Bays Wastewater Treatment Facility is a secondary treatment facility designed to treat a summer maximum monthly average daily flow of 2.0 MGD and consists of an activated sludge system with two phased-aeration basins for biological nutrient removal (BNR), two clarifiers, one chlorine contact chambers for disinfection, a 39 million gallon effluent storage lagoon, a 32 million gallon storage lagoon and solids handling facilities.

The system's design disposal capacity is 2.65 MGD. The treated wastewater is spray irrigated onto 432.5 acres via eight center pivot spray irrigation systems. The wetted fields will be planted in corn (grain) and soybean (grain) during the summer growing season and in winter wheat during the winter.

Design Treatment Capacity: 2.0 MGD

Design Flows:

Season	**Flow Rate (MGD)**
Summer Maximum Month ADF	2.0 MGD
Summer Average Month ADF	1.8 MGD
Winter Maximum Month ADF	1.5 MGD
Winter Average Month ADF	1.4 MGD
Annual Average ADF	1.5 MGD
Peak Day Flow	3.7 MGD

Design Disposal Capacity:

Wetted Field Area	**Acres**	**Rate (in/wk)**	**Effluent Disposal Capacity (MGD)**	**Sussex County Tax Map No.**
North Field	103.0	1.86	0.73	2-34-22-12
South Field	103.0	1.86	0.73	2-34-22-16
North Burton Field	52.0	1.5	0.3	2-34-22-12
South Burton Field	41.9	1.0	0.18	2-34-22-12
North Hettie-Lingo Field	47.5	1.0	0.18	2-34-22-19
South Hettie-Lingo Field	30.48	2.0	0.24	2-34-22-19
East Hettie-Lingo Field	34.46	1.0	0.13	2-34-22-19
West Hettie-Lingo Field	20.16	2.0	0.16	2-34-22-19
Total	432.5		2.65	

C. INFLUENT LIMITATIONS

1. The average monthly quantity of influent to the wastewater treatment facility shall not exceed 2.0 Million Gallons per Day.

   Design Treatment Capacity: 2.0 MGD

D. SPRAYED EFFLUENT LIMITATIONS

During the period beginning on the effective date and lasting through the expiration date of this permit, the permittee is authorized to discharge to the spray irrigation field(s) identified on page 1 of this permit the quantity and quality of effluent specified below:

1. The average monthly quantity of effluent discharged from the wastewater treatment facility to the spray fields shall not exceed 2.65 Million Gallons per Day in any calendar month.

   Design Disposal Capacity: 2.65 MGD

2. The average weekly quantity of effluent discharged to the spray irrigation fields shall not exceed the following limits.

Wetted Field Area	Rate (in/wk/acre)
North Field	1.86
South Field	1.86
North Burton Field	1.5
South Burton Field	1.0
North Hettie-Lingo Field	1.0
South Hettie-Lingo Field	2.0
East Hettie-Lingo Field	1.0
West Hettie-Lingo Field	2.0

3. The quantity of effluent discharged to any portion of the spray irrigation field shall not exceed 0.25 inches/acre/hour.

4. There shall be a minimum rest period of twenty-four (24) hours between applications on each spray field.

5. There shall be a minimum one (1) hour rest period when the center pivot reaches any in-field end stops if the instantaneous application rate exceeds a rate of 0.125 inches/acre in any one hour.

6. The pH of the effluent shall not be less than 5.5 standard units nor greater than 9.0 standard units.

7. The total residual chlorine concentration shall not be less than 1.0 mg/L nor more than 4.0 mg/L.

8. The Chloride concentration of the effluent shall not exceed 250 mg/L on an average annual basis.

9. The Sodium concentration of the effluent shall not exceed 210 mg/L on an average annual basis.

10. The total amount of nitrogen that may be applied to each spray field acre shall not exceed 250 lbs/year.

This amount includes supplemental fertilizers, the nitrogen supplied from the effluent, and any other source. The limitation of total nitrogen that can be applied to each acre may be adjusted by the Ground Water Discharges Section if it can be shown through subsequent analysis of the crop removed that the total nitrogen removed with the crop is equal to the amount applied from the effluent and additional fertilizer applications. Supplemental additions of commercial fertilizers shall be limited to amounts necessary to meet crop needs in accordance with the written recommendations of the University of Delaware Cooperative Extension Service for the specified crop and anticipated yield.

11. The discharge to the spray irrigation fields shall be free from material such as floating solids, sludge deposits, debris, scum, oil and grease in quantities that would be deleterious to the proper operation and maintenance of the spray fields.

12. Because the facility has been designed for Restricted Public Access, the effluent must meet the following limits:

Parameter	**Daily Permissible Average Concentration at Design Flows**
BOD_5	50.0 mg/L
Total Suspended Solids	90.0 mg/L
Fecal Coliform	200 colonies/100 mL

E. BUFFER REQUIREMENTS

1. A buffer zone of at least 150 feet shall be maintained between the edge of the wetted field area and all highways, individual lots and property lines.
2. A buffer zone of 50 feet shall be maintained between the wetted edge of the spray field and the edge of any wetlands or any perennial lake or stream provided that the buffer zone is maintained in perennial vegetation.
3. A buffer zone of 100 feet shall be maintained between the wetted edge of the spray field and all other areas not previously mentioned in items 1 and 2 of Buffer Requirements.

F. GROUND WATER REQUIREMENTS

Operation of the wastewater treatment facility and spray irrigation system shall not cause the quality of Delaware's ground water resources to be in violation of applicable Federal or State Drinking Water Standards on an average annual basis.

G. MONITORING REQUIREMENTS

Permittee shall initiate periodic reporting required under Part I.I.2 upon initiation of irrigation activities for all of the following monitoring requirements.

During the period beginning on the effective date and lasting through the expiration date of this permit, the permittee is authorized to discharge to spray irrigation fields identified on page 1 of this permit. Such discharge shall be monitored by the permittee as specified as follows:

1. INFLUENT MONITORING REQUIREMENTS

Parameter	Sample Location	Unit Measurement	Monitoring Frequency	Sample Type
BOD_5	Influent	mg/L	Monthly	Composite
Influent Flow	Plant Inlet	Gal/day	Continuous	Recorded/Totalized
pH	Influent	S.U.	Monthly	In-situ
TSS	Influent	mg/L	Monthly	Composite

2. SPRAYED EFFLUENT MONITORING REQUIREMENTS

Samples taken in compliance with the monitoring requirements for all parameters specified above shall be taken from the irrigation pump station wet well with the exception of Total Residual Chlorine, PH, and Fecal Coliform which shall be taken at the wet well located at the effluent end of the chlorine contact chamber.

Parameter	Unit Measurement	Monitoring Frequency	Sample Type
Ammonia Nitrogen	mg/L	Monthly	Composite
BOD_5	mg/L	Twice per month	Composite
Cadmium	mg/L	Annually	Composite
Chloride	mg/L	Quarterly	Composite
Copper	mg/L	Annually	Composite
Effluent Flow	Gal/day	Continuous	Recorded/Totalized
Fecal Coliform	Col/100 ml	Twice per month	Grab
Lead	mg/L	Annually	Composite
Nickel	mg/L	Annually	Composite
Nitrate + Nitrite Nitrogen	mg/L	Monthly	Composite
Organic Nitrogen	mg/L	Monthly	Calculation
pH	S.U.	Daily	In-situ
Potassium	mg/L	Quarterly	Composite
Sodium	mg/L	Quarterly	Composite
Total Nitrogen	mg/L	Monthly	Composite
Total Phosphorus	mg/L	Monthly	Composite
Total Residual Chlorine	mg/L	Daily	Grab
Total Suspended Solids	mg/L	Twice per month	Composite
Zinc	mg/L	Annually	Composite

3. GROUND WATER MONITORING REQUIREMENTS

a. MONITORING WELLS

Parameter	Unit Measurement	Measurement Frequency	Sample Type
Ammonia as Nitrogen	mg/L	Quarterly	Grab
Chloride	mg/L	Quarterly	Grab
Depth to Water	hundredths of a foot	Monthly	In-Situ
Dissolved Oxygen	mg/L	Quarterly	Field Test
Fecal Coliform	Col/100mL	Quarterly	Grab
Nitrate + Nitrite as Nitrogen	mg/L	Quarterly	Grab
pH	S.U.	Quarterly	Field Test
Sodium	mg/L	Quarterly	Grab
Specific Conductance	µS/cm	Quarterly	Field Test
Temperature	°C	Quarterly	Field Test
Total Dissolved Solids	mg/L	Quarterly	Grab
Total Nitrogen	mg/L	Quarterly	Grab
Total Phosphorus	mg/L	Quarterly	Grab

i. Samples taken in compliance with the monitoring requirements specified above shall be taken at each monitoring well (excluding observation wells) in accordance with procedures approved by the Department and listed in the State of Delaware, Field Manual for Groundwater Sampling (Custer, 1988).

ii. Ground water monitoring results for each monitoring well shall be reported using the State of Delaware Well Identification Tag Number that is required on all wells in accordance with the Delaware Regulations Governing the Construction and Use of Wells, Section 10, A.

iii. After notice and opportunity for a hearing the Department may modify the list of parameters to be monitored or the frequency monitoring by the permittee based upon observations of ground water quality trends in the area.

b. GROUND WATER TABLE ELEVATION MONITORING REQUIREMENTS
Ground water level measurements shall be taken from the five observation wells installed on the North Burton, South Burton, North Hettie Lingo, South Hettie Lingo and between the West and East Hettie Lingo Fields in accordance with the following:

Parameter	Unit Measurement	Measurement Frequency	Sample Type
Depth to Water	hundredths of a foot	Monthly	In-Situ

c. While performing the monitoring as required by Part I.G.3 or I.G.4 of this permit, if the 'Depth to Water' in any one of the following monitoring wells lies within 3 feet of the ground surface, the permittee shall be required to collect additional weekly depth to water measurements from that monitoring well. The permittee may discontinue the additional weekly sampling for depth to water when the water table in each well is deeper than 3 feet below ground surface. The additional monitoring is necessary to ensure that spray irrigation ceases on any area of the spray fields where the ground water lies within 2 feet of the ground surface in accordance with Part III.A.3 of this permit. The additional water table measurements must be recorded in the operator's log, and must be reported to the Ground Water Discharges Section in accordance with Part I.I.2 of this permit.

4. LYSIMETER MONITORING REQUIREMENTS

Lysimeter monitoring sampling shall be taken from the lysimeters installed on the North Burton, South Burton and North Hettie Lingo and East Hettie Lingo Fields. The constituents are listed below in highest priority first. In the event that enough sample is not obtained to test for all parameters listed, the sample shall be tested for as many constituents possible in the following order:

Parameter	Unit Measurement	Measurement Frequency	Sample Type
Total Nitrogen	mg/L	Quarterly	Grab
Total Phosphorus	mg/L	Quarterly	Grab
Nitrate + Nitrite as Nitrogen	mg/L	Quarterly	Grab
Ammonia as Nitrogen	mg/L	Quarterly	Grab
Chloride	mg/L	Quarterly	Grab
Sodium	mg/L	Quarterly	Grab
Total Dissolved Solids	mg/L	Quarterly	Grab
pH	S.U.	Quarterly	Field Test
Specific Conductance	µS/cm	Quarterly	Field Test
Temperature	°C	Quarterly	Field Test

5. SOIL MONITORING REQUIREMENTS

Composite soil samples representing each soil series within the wetted spray field should be taken within the upper 12 inches of soil. A minimum of one composite sample for every 20 acres of each soil series is required.

Soil sample locations shall be plotted on a scaled drawing and labeled consistent with the sample nomenclature. Each field must also be identified so that sample results may be tracked and properly assessed for field life limiting factors.

Parameter	Unit Measurement	Measurement Frequency	Sample Type
pH	S.U.	Annually	Soil Composite
Organic Matter	%	Annually	Soil Composite
Phosphorus (as P2O5)	mg/kg	Annually	Soil Composite
Potassium	mg/kg	Annually	Soil Composite
Sodium Adsorption Ratio	meq/100g	Annually	Soil Composite
Cadmium	mg/kg	Once per 4 years	Soil Composite
Nickel	mg/kg	Once per 4 years	Soil Composite
Lead	mg/kg	Once per 4 years	Soil Composite
Zinc	mg/kg	Once per 4 years	Soil Composite
Copper	mg/kg	Once per 4 years	Soil Composite
Cation Exchange Capacity	meq/100g	*Only if soil pH changes significantly	Soil Composite
Phosphorus Adsorption	meq/100g	**Only if soil phosphorus levels become excessive for plant growth	Soil Composite
Percent Base Saturation	%	*Only if soil pH changes significantly	Soil Composite

*A significant change in soil pH is defined as a change of one or more standard units from the original value established in the Design Development Report.

** Excessive levels of soil phosphorus are defined by the Delaware Nutrient Management Commission. Soil phosphorus levels must be tested in accordance with the University of Delaware soil testing methods. If the soil phosphorus levels become excessive, the permittee shall perform a Phosphorus Site Index (PSI) study of the site. The results of the PSI study must be submitted to the Ground Water Discharges Section within 30 days of completion of the study. Based on the results of the PSI study, the Ground Water Discharges Section may require the permittee to submit a plan for Ground Water Discharges Section review and approval detailing steps the permittee will take to reduce the phosphorus loading rates at the site to crop uptake levels.

H. Schedule of Compliance

1. The permittee shall submit information necessary for proper operation of the spray irrigation system in accordance with the following schedule:

   None

2. The permittee shall submit either a report of progress or, in the case of specific actions being required by identified dates, a written notice of compliance or noncompliance by specified date. In the event of noncompliance, the notice shall include the cause of noncompliance, any remedial action taken, and the probability of meeting the next scheduled requirement.

I. Monitoring and Reporting

1. Representative Sampling

   Samples and measurements taken as required herein shall be representative of the volume and nature of the monitored discharge.

   The permittee shall automatically resample the wastewater and submit to the Department additional analyses if there has been significant increase (greater than 25%) in the characterization of any one parameter of the effluent wastewater as established in the Design Development Report. The permittee shall then be required to recharacterize the wastewater in order to determine if any change in the land limiting constituent has occurred. Any significant change in wastewater characteristics that affects the land limiting constituent shall be included in a revised Design Development Report which shall be submitted to the Department. After a review of these results, the Department may invoke the provisions of Part II.B.6 of this permit.

2. Reporting

Monitoring results obtained during the previous one month/quarter shall be summarized for each month/quarter and reported on an approved Spray Effluent Monitoring Report Form postmarked no later than the 28th day of the month following the completed reporting period. Signed copies of these, and all other reports required herein, shall be submitted to the Department at the following address:

Ground Water Discharges Section
Division of Water
Department of Natural Resources and Environmental Control
20653 Dupont Blvd, Unit 5
Georgetown DE 19947
Telephone: (302) 856-4561 Office
(302) 542-9735 Cell

a. Additional Monitoring by Permittee

If the permittee monitors any parameter at the location(s) designated herein more frequently than required by this permit, using approved analytical methods specified herein, the results of such monitoring shall be included in the calculation and reporting of the values required in the appropriate Monitoring Report Form. Such increased frequency shall also be indicated.

b. The permittee shall submit to the Department an annual operation report on or before February 1 of each year. The annual operation report shall summarize operational and maintenance activities at the facility along with management and administration of the facility and shall include the following:

i. The annual volume of wastewater spray irrigated on each field along with the total nitrogen and phosphorus loading applied to each irrigation field in pounds per acre per field as well as total pounds removed;

ii. A chemical analysis of soils from each field for the constituents identified in Part I.G.5 of this permit;

iii. Identification of those portions of the field(s) which have been prone to ponding, pooling or runoff; and

iv. The vegetative management practices followed during the previous year and anticipated for the coming year.

v. The type and amount of crop removed under spray irrigation.

vi. Documentation verifying the calibration of influent and effluent flow meters.

c. Compliance Monitoring Report

At least 180 days before the expiration date of this permit, the permittee must submit a five year Compliance Monitoring Report (CMR) with the application for renewal. The CMR must be in accordance with current Department Guidelines. CMR requirements are currently outlined in the November 13, 2008 amendment to the *Wastewater Treatment and Disposal System Siting, Design, and Operation: Supplemental Guidance to the Existing Regulations Governing the Design, Installation and Operation of On-Site Wastewater Treatment and Disposal Systems and the Regulations Governing the Land Treatment of Wastes*. Please check with the Department prior to completing the CMR for the most current Guidelines regarding the CMR.

3. Test Procedures

Test procedures for analysis of pollutants shall conform to the applicable test procedures identified in 40 C.F.R., Part 136 or the most recently adopted copy of Standard Methods unless otherwise specified in this permit.

Soil chemical testing should be in accordance with Methods of Soil Analysis published by the American Society of Agronomy, Madison, Wisconsin.

4. Recording of Results

For each measurement or sample taken pursuant to the requirements of this permit, the permittee shall record the following information:

a. The exact place, date and time of sampling and/or measurement;
b. The person(s) who performed the sampling and/or measurement;
c. The date(s) the analyses were performed and the time the analyses were begun;
d. The person(s) who performed the analyses; and
e. The results of each analysis.

5. Records Retention

All records and information resulting from the monitoring activities required by this permit including all records of analyses performed, calibration and maintenance of instrumentation and recording from continuous monitoring instrumentation shall be retained for five years. This period of retention shall be extended automatically during the course of any unresolved litigation regarding the regulated activity or regarding control standards applicable to the permittee, or as requested by the Department.

6. Quality Assurance Practices

The permittee is required to show the validity of all effluent monitoring and ground water monitoring data by requiring its laboratory to adhere to the following minimum quality assurance practice:

a. Duplicate(1) and spiked(2) samples must be run for each effluent monitoring and ground water monitoring constituent in the permit on 5% of the samples, or at least on one sample per quarter, whichever is greater. If the analysis frequency is less than one sample per quarter, duplicate and/or spiked samples must be run for each analysis;
b. For spiked samples, a known amount of each constituent is to be added to the discharge sample. The amount of constituent added should be approximately the same amount present in the unspiked sample, or must be approximately that stated as maximum or average in the discharge permit;

c. The data resulting from a and b shall be summarized in the annual report submitted pursuant to Part I.I.2.b of this permit in terms of precision; percent recovery; number of duplicate and spiked samples run; date and laboratory log number of samples run, and name of analyst;

d. Precision shall be calculated by the standard deviation (s) formula $s = (\Sigma d^2/k)^{1/2}$, where d is the difference between duplicate results, and k is the number of duplicate pairs used in the calculations;

e. Percent recovery (R) shall be reported on the basis of the formula $R = 100\ (F\text{-}I)/A$, where F is the analytical result of the spiked sample, I is the result before spiking of the sample, and A is the amount of constituent added to the sample;

f. The percent recovery in Quality Assurance Practice e above shall be summarized yearly in terms of mean recovery and standard deviation from the mean. The formula, $s = [\Sigma(x_{mean}\text{-}x)^2/(n\text{-}1)]^{(1/2)}$, where s is the standard deviation around the mean x-x, x is an individual recovery value, and n is the number of data points, shall be applied;

g. The permitee or contract laboratory is required to annually analyze an external quality control reference sample for each pollutant. These are available through the EPA regional quality assurance coordinator. Results shall be included in the annual report, Quality Assurance Practice c above;

h. The permittee and/or contract laboratory is required to maintain an up-to-date and continuous record of the method used, any deviations from the method or options employed in the reference method, reagent standardization, equipment calibration and the data obtained in Quality Assurance Practices a, b and f above; and

i. If a contract laboratory is utilized, the permittee shall report the name and address of the laboratory and the parameters analyzed together with the monitoring data required.

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(1) Duplicate samples are not required for the following parameters: color, temperature, and turbidity.

(2) Spike samples are not required for the following parameters: Acidity, Alkalinity, Bacteriological, Benzidine, Chlorine, Color, Dissolved Oxygen, Hardness, pH, Oil & Grease, Radiological, Residues, Temperature, Turbidity, BOD_5 and Total Suspended Solids.

J. DEFINITIONS

1. Bypass - The intentional diversion of wastes from any portion of a treatment facility.

2. Composite sample - A combination of individual samples obtained at intervals over a time period. Either the volume of each individual sample is proportional to discharge flow rates or the sampling interval (for constant volume samples) is proportional to the flow rates over the time period used to produce the composite. For a 8-24 hour discharge, a minimum of 24 individual grab samples shall be collected and combined to constitute a composite sample. For intermittent discharges of 4-8 hours duration, a minimum of 12 grab samples shall be collected and combined to constitute the composite sample for the discharge. For intermittent discharges of less than 4 hours, a minimum of individual grab samples shall be collected and combined to constitute the composite samples collected equal to the duration of the discharge in hours times 3 but not less than 3 samples.

3. Grab sample - An individual sample collected in less than 15 minutes.

4. In-situ – Data is collected in stream or in place without interrupting the normal flow process.

5. Field Test – A test or measurement performed in the field using a calibrated water-quality instrument. Such tests include, but are not limited to, pH, specific conductance, and temperature. For ground water sampling purposes, these parameters must be monitored during well purging and allowed to stabilize prior to the collection of samples for laboratory analysis.

6. Daily average concentration - The daily average concentration shall be determined by the summation of all the measured daily concentrations obtained from composite samples divided by the number of days during the calendar month when the measurements were made.

7. Daily maximum concentration - The concentration of a pollutant in terms of milligrams per liter which represents the value obtained from a composite sample of an effluent over a 24 hour period.

8. Land Treatment - A technology for the intimate mixing or dispersion of wastes into the upper zone of the plant-soil system with the objective of microbial stabilization, immobilization, selective dispersion, or crop recovery leading to an environmentally acceptable assimilation of the waste.

9. Spray Irrigation - the controlled application of treated wastewater to a vegetated soil surface.

10. Soil composite - At least ten individual cores which have been mixed together to form one sample. The cores shall be collected in a manner such that the final sample is representative of the soils found on the field.

11. Treatment - A process which alters, modifies, or changes the biological, physical, or chemical characteristics of sludge or liquid waste.

PART II

A. MANAGEMENT REQUIREMENTS

1. Spray Irrigation of Wastewater

An operator log must be kept on site at all times. Each spray system section shall be numbered and referred to by number in the operator log. All records and reports shall also be kept on site at all times. This log shall, at a minimum, include the following:

a. Time spent at the treatment facility on any date;

b. Details of the operation and maintenance performed on the wastewater treatment and spray irrigation facility on any date;

c. The volume of wastewater sprayed on each field on any date and the acreage over which the wastewater was sprayed;

d. Identification of those portions of the field(s) that were ponding on any date;

e. A record of any deviations from the operation and maintenance manual;

f. General daily weather conditions;

g. A site map showing the spray area with each center pivot or solid set spray zone numbered;

h. A record of all actions taken to correct violations of the Delaware Environmental Protection Act and the Department's regulations; and

i. A record of all site management activities undertaken such as planting, reseeding, harvesting of crops, commercial fertilizer applications and any other chemical additions or applications.

2. Change in Discharge

All discharges authorized herein shall be consistent with the terms and conditions of this permit. The discharge of any pollutant identified in this permit more frequently than or at a level in excess of that authorized shall constitute a violation of the permit.

Any anticipated facility expansions, production increases, or process modifications which will result in new, different, or increased discharges of pollutants must be submitted to the Ground Water Discharges Section for approval in accordance with Part II. B. Subsection 203 (4) (b) [Major Modifications] of the Regulations. The procedure for making major modifications shall be the same as that used for a new permit under the regulations.

Any other activity which would constitute cause for modification or revocation and reissuance of this permit as described in Part II.B.6 of this permit shall be reported to the Ground Water Discharges Section. Following such notice, the permit may be modified to specify and limit any pollutants not previously limited.

3. Non-compliance Notification

The permittee shall report to the Department's Enforcement Section at (800) 662-8802 any unpermitted release or discharge of any contaminant into the air, or a pollutant, including petroleum substances, into surface waters, ground water, or onto land as soon as the permittee has knowledge of the release or discharge.

The permittee shall report to the Ground Water Discharges Section orally within 24 hours from the time the permittee became aware of any noncompliance that may endanger the public health or the environment by contacting the Department at the telephone numbers cited in Part I.I.2 of this permit.

If for any reason the permittee does not comply with, or will be unable to comply with, any effluent limitations or other conditions specified in this permit, the permittee shall provide the Department with the following information in writing within 5 days of becoming aware of any actual or potential non-compliance:

a. A description and cause of the non-compliance with any limitation or condition;

b. The period of non-compliance including exact dates and times; or, if not yet corrected, the anticipated time the non-compliance is expected to continue; and

c. The steps being taken or planned to reduce, eliminate and/or prevent recurrence of the non-compliant condition.

4. Facilities Operation

The permittee shall at all times properly maintain and operate as efficiently as possible all structures, systems and equipment for treatment control and monitoring which are used by the permittee to achieve compliance with the terms and conditions of this permit. Proper operation and maintenance includes, but is not limited to, effective performance based on designed facility removals, adequate funding, effective management, adequate operator staffing and training, and adequate laboratory and process controls including appropriate quality assurance procedures.

5. Facility and Operation Changes

The permittee shall submit a written report to the Department for review and approval, of any changes to the facility or operation of the system within the following time periods:

a. Thirty days before any planned activity, physical alteration to the permitted facility or addition to the permitted facility if that activity, alteration or addition would result in a change in information that was previously submitted to the Department;

b. Thirty days before any anticipated change which would result in noncompliance with any permit condition or the regulations; or

c. Immediately after the permittee becomes aware of relevant facts omitted from, or incorrect information submitted in, a permit application or report to the Department. Omitted facts or corrected information shall be submitted as soon as possible and will be included as part of the report.

6. Adverse Impact

The permittee shall take all reasonable steps to minimize any adverse impact to waters of the state resulting from operation under this permit. Such steps shall include, but not be limited to, accelerated or additional monitoring as necessary to determine the nature and impact of the non-complying discharge or reasonable mitigation of such impacts.

7. Bypassing

Any bypass of treatment facilities (including pretreatment, storage, distribution and land application facilities) necessary to maintain compliance with the terms and conditions of this permit is prohibited unless:

a. The bypass is unavoidable to prevent loss of life, personal injury or severe property damage;

b. There are no alternatives;

c. The Department is orally notified within 24 hours after such bypass; and, a written submission regarding the bypass is submitted within five days of the permittee's becoming aware of the bypass. Where the need for a bypass is known (or should have been known) in advance, this notification shall be submitted to the Department for approval at least ten days prior or as soon as possible before the date of bypass; and

d. The bypass is allowed under conditions determined by the Department to be necessary to minimize adverse effects as provided under 7 Del. C., Chapter 60, §6011.

8. Initiation of Facility Operations Notification

If this permit involves the construction of new facilities or modifications to existing facilities, the permittee shall notify the Department at least fifteen days prior to the intent to initiate operations. Permittee must schedule to have Ground Water Discharge Section staff present at the initiation of operations to perform a start up inspection. If the results of the inspection are satisfactory, written authorization will be issued for continued operation. In the event the inspection results are not satisfactory, a letter of deficiency will be issued detailing remedial action necessary. After remedial action has been completed, the permittee must schedule the Ground Water Discharges Section to perform another start up inspection. The permittee must obtain written authorization from the Ground Water Discharges Section prior to commencing operations.

9. Removed Substances

Solids, sludges, filter backwash or other pollutants removed in the course of treatment or control of wastewater shall be disposed of in a manner such as to prevent any pollutant from entering the surface water or ground water and to comply with applicable federal or state laws and regulations.

10. Power Failures

An alternative power source, which is sufficient to operate the wastewater treatment and disposal facilities, shall be available. If such alternative power source is not available, the permittee shall halt, reduce or otherwise control production and/or all discharges upon the reduction, loss, or failure of the primary source of power to the wastewater facilities.

B. RESPONSIBILITIES

1. Reapplication for a Permit

At least 180 days before the expiration date of this permit, the permittee shall submit a new application for a permit or notify the Department of the intent to cease discharging by the expiration date. In the event that a timely and complete application has been submitted as determined by the Department, and the Department is unable, through no fault of the permittee, to issue a new permit before the expiration date of this permit, the terms and conditions of this permit are automatically continued and remain fully effective and enforceable until a decision is made on the new application.

2. Submission of As-Built Plans

Within 90 days following the completion of construction of new facilities or modifications to existing facilities, the permittee shall submit to the Department a set of as-built plans of the facility bearing the seal and signature of a Professional Engineer registered in the State of Delaware. As-built drawings shall incorporate the new contours, treatment system, and spray irrigation system, along with the elevations of monitoring wells at the top of the casing and at the ground surface, and local topography tied to a common bench mark. The location and screen depth must also be provided for the monitoring wells.

3. Right of Entry

The permittee shall allow, at reasonable times, the Secretary of the Department of Natural Resources and Environmental Control, or his authorized representatives, upon the presentation of credentials and such other documents as may be required by law:

a. To enter upon the permittee's premises where the spray irrigation facility is located or where any records are required to be kept under the terms and conditions of this permit;

b. To have access to and copy any records required to be kept under the terms and conditions of this permit;

c. To inspect any facility, equipment, monitoring method, monitoring equipment, practice or operation permitted or required under this permit; and

d. To sample or monitor for the purpose of assuring permit compliance with any condition of this permit, the regulations or 7 Del C., Chapter 60.

4. Transfer of Ownership and Control

No person shall transfer a permit from one location to another, or from one piece of equipment to another. No person shall transfer a permit from one person to another unless 30 days written notice is given to the Department, indicating the transfer is agreeable to both persons, and approval of such transfer is obtained in writing from the Department, and any conditions of the transfer approved by the Department are complied with by the transferor and the transferee.

The notice to the Department shall contain a written agreement between the transferor and the transferee, indicating the specific date of proposed transfer of permit coverage and acknowledging responsibilities of current and new permittees for compliance with and liability for the terms and conditions of this permit. The notice shall be signed by both the transferor and the transferee.

5. Availability of Reports

All reports prepared in accordance with the terms of this permit shall be available for public inspection at the offices of the Department of Natural Resources and Environmental Control. Monitoring data shall not be considered confidential. Knowingly making any false statement on any such report may result in the imposition of criminal penalties as provided for in 7 Del. C., §6013.

6. Permit Modification, Revocation and Termination

After notice and opportunity for a hearing, this permit may be modified, terminated, or revoked in whole or in part during its term for cause including, but not limited to, any of the following:

a. Violation of any terms of conditions of this permit, the regulations, 7 Del. C., Chapter 60 or failure to pay applicable Department fees;

b. Obtaining this permit by misrepresentation or failure to fully disclose all relevant facts;

c. A change in any condition that requires either a temporary or permanent reduction or elimination of the authorized discharge; or

d. If the Department finds that the health, safety or welfare of the public requires emergency action, the Department shall incorporate findings in support of such action in a written notice of emergency revocation issued to the permittee. Emergency revocation shall be effective upon receipt by the permittee. Thereafter, if requested by the permittee in writing, the Department shall provide the permittee a revocation hearing and prior notice thereof. Such hearings shall be conducted in accordance with 7 Del. C., Chapter 60.

7. State Laws

This permit shall not be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable state law or regulation.

8. Property Rights

The issuance of this permit does not convey any property rights of either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of federal, state or local laws or regulations.

9. Severability

The provisions of this permit are severable. If any provision of this permit, or the application of any provision of this permit, to any circumstances is held invalid; the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

PART III

A. GENERAL CONDITIONS

1. The spray irrigation fields shall be managed to assure at a minimum that:

    a. Spray irrigation of wastewater shall not occur on barren fields.

    b. The spray fields shall be maintained in such a manner as to prevent wastewater pooling and/or discharge of wastewater to any surface waters. Should pooled areas become evident, no spraying shall be conducted in those areas until saturated conditions no longer exist.

    c. No aerosols or nuisance odors shall extend beyond the boundary of the spray irrigation site when treated wastewater is being applied. If odors are produced that are considered to be a public nuisance, the permittee shall take the necessary steps to eliminate such odors. All action taken shall be reported to the Department in accordance with Part II.A.3 of this permit.

    d. Erosion controls are employed to prevent wastewater runoff from the spray irrigation fields. The permittee must notify the Department immediately if any wastewater runoff occurs.

    e. The spray irrigation field's crops must be maintained in optimal condition, including any necessary weed management, reseeding, or other vegetative management.

    f. Effective vegetative management shall be provided such that crops harvested on the spray irrigation sites are removed from the sites.

    g. The wastewater must be applied in a manner such that the application is even and uniform over the irrigation area.

2. Spray irrigation is prohibited when saturated or frozen soil conditions exist.

3. The ground water mound created by the added infiltration shall at no time reach within two feet of the ground surface in any section of the spray irrigation fields. Should the ground water mound exceed this limit, the permittee shall cease all irrigation of wastewater to the affected fields until the ground water mound recedes to acceptable levels.

4. All construction activities shall be in agreement with the plans and specifications submitted under this project and approved by the Ground Water Discharges Section; and other applicable local utility construction specifications and standards. Connections or additions to the spray irrigation system other than those indicated on the approved plans are prohibited without prior approval from the Ground Water Discharges Section.

5. Roof downspouts, foundation drains, area drains, storm sewers, combined sewers or appurtenances thereto or any sewer or device carrying storm water shall not be connected to the spray irrigation system.

6. The permittee shall take appropriate measures to protect the spray irrigation system from damage due to sub-freezing conditions. Any leaks associated with such conditions shall be reported to the Department and repaired immediately.

7. Signs must be posted along the perimeter of, and at all entry points to, areas utilizing treated wastewater for irrigation to discourage public contact with the effluent. The signs must indicate that the water being irrigated is treated wastewater. The signs must be legible.

8. Potable ground or surface water may be used for distribution system testing and irrigation to establish vegetation when sufficient treated effluent is not available.

9. In the event that the permittee installs new monitoring wells or replaces any existing monitoring wells, the permittee shall submit to the Ground Water Discharges Section new elevation details relative to the common benchmark previously established. Additionally, the permittee shall conduct a ground water quality sampling program prior to initiation of spray irrigation activities on the area incorporating the well. The sampling program shall be sufficient to establish a representative ground water quality at each well prior to initiation of the spray irrigation activities on the area incorporating the well. A minimum of three (3) samples shall be collected at least one month apart and analyzed. A Summary report which includes all analyses shall be submitted to the Ground Water Discharges Section prior to initiation of spray irrigation activities. Analyses shall include the following:

Ammonia Nitrogen		Nitrate + Nitrite Nitrogen	Temperature
Arsenic	Fecal Coliform		Total Dissolved Solids
Cadmium	Hardness	Organic Nitrogen	Total Nitrogen
Chloride	Iron	pH	
Chromium	Lead	Selenium	Total Phosphate as P
Copper	Manganese	Sodium	Total Phosphorus
Depth to water to 0.01ft from a surveyed point on TOC	Mercury	Specific Conductance	Total Suspended Solids
Dissolved Oxygen	Nickel	Sulfate	Zinc

10. The permittee must calibrate all flow meters in accordance with the Manufacturer's recommendations. Calibration shall include, but not be limited to influent, effluent, continuous online turbidity and chlorine residual monitors. The calibration documentation must be submitted with the Annual Report in accordance with Part I.I.2.b.vi.

11. The permittee shall operate and maintain the land treatment system in accordance with the approved Operation and Maintenance Plan.

12. Written permission must be obtained from the Ground Water Discharges Section prior to utilizing the freeboard in any lagoon.

13. This permit does not relieve the permittee of complying with any other applicable Federal, State or local regulations.

14. In the event that the Guidance and Regulations Governing the Land Treatment of Wastes or applicable federal regulations are revised, this permit may be opened and modified accordingly after notice and opportunity for a public hearing.

15. This permit supersedes all previous spray irrigation permits issued to the permittee.

B. FACILITY SPECIFIC CONDITIONS

1. A classification was performed on the permitted facility in accordance with Regulations Licensing Operators of Wastewater Facilities. The wastewater treatment system is designated as a Class III Facility. The facility must be under the direction of a Class III Licensed Operator in Direct Responsible Charge for the facility who is available at all times. A licensed operator, operating under the direction of the licensed operator in Direct Responsible Charge for the facility, must be available when the spray irrigation system is in operation.

2. Within 90 days of the issuance date of this Amended Permit, Permittee must address the "Requirements" in the February 6, 2013 DNREC Hydrogeological Review.

3. Within 90 days of the issuance date of this Amended Permit, Permittee must address the "Requirements Prior to Issuance of an Operation Permit" iterated in the February 24, 2013 email to Heather Sheridan, Sussex County.

PART IV

A. AMENDMENTS TO STATE PERMIT LTS 5004-90-12 ISSUED JULY 13, 2012

1. Amended October 16, 2012

   Part I.G.2 Page 9 Deleted monitoring requirement for Enterococcus

   Part III.A.9 Page 22 Deleted monitoring requirement for Enterococcus

2. Amended March 14, 2013

   Page 1 amended location information

   Part I.A additional documentation added Numbers 16-19

   Part I.B updated system's design disposal capacity to 2.65 MGD; disposal acreage to 432.5 acres

   Part I.D.1 updated system's design disposal capacity to 2.65 MGD

   Part I.D.2 included additional spray fields and discharge rate limits

   Part I.G.3.b added ground water level measurement requirements

   Part I.G.3.c relocated requirements from Part I.G.6

   Part I.G.4 added lysimeter monitoring requirement for East Hettie Lingo Field

   Part III.A.9 modified monitoring requirements

   Part III.B.2 added requirement for Permittee to address the "Requirements" in the February 6, 2013 DNREC Hydrogeological Review

   Part III.B.3 added requirement for Permittee to address the "Requirements Prior to Issuance of an Operation Permit" iterated in the February 24, 2013 email to Heather Sheridan, Sussex County.